THE

AGRICULTURAL LEDGER.

1905.

(BEING VOL. XII.)

EDITED BY

THE REPORTER ON ECONOMIC PRODUCTS TO THE GOVERNMENT OF INDIA.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1906.

A

GENERAL INDEX

TO

THE AGRICULTURAL LEDGER

FOR THE YEARS

1900—1905.

VOLS. VII—XII.

NOTE.

This Index completes the volume for 1905.

CONTENTS.

NOTE.

To those who bind the *Agricultural Ledger* two alternatives are suggested; they may bind the issues of each year into an annual volume, or they may keep apart the Series into which it is divided.

These Series are as follows :—

I.—VEGETABLE PRODUCT SERIES.
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III.—MINERAL AND METALLIC SERIES.
IV.—AGRICULTURAL SERIES.
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IX.—MEDICAL AND CHEMICAL SERIES.
X.—IMPLEMENT AND MACHINERY SERIES.
XI.—CROP DISEASE AND PEST SERIES.
XIII.—MISCELLANEOUS SERIES.

For either purpose indexes will be published. The annual index will continue to appear year by year; the "serial" indexes will appear at wider intervals.

The annual index refers to the numbering which heads the pages: the numbering at the foot, which is consecutive in each Series, will be used in the serial indexes.

Public libraries and similar institutions are likely to find the plan of binding in annual volumes the more convenient one.

I. HENRY BURKILL,

Officiating Reporter on Economic Products to the Government of India.

ERRATA.

No. 2 (1905). Phaseolus lunatus.—Report on the Chemical Examination of the Beans, page 11, line 14 from bottom, for *pe-saulagu* read *pe-santagu*. However, the name *pe-santagu* does not properly belong to Phaseolus lunatus.

No. 3 (1905). Saltpetre.—Manufacture and Composition of Indian Saltpetre, page 18, line 12, *for* Schlossing *read* Schloesing.

It is also necessary to correct an error which has crept into the Serial Paging of the **Vegetable Product Series**, beginning with No. 1 of 1905, and which runs through Nos. 89, 90, 91, 92 of the Series, thus :—

	Present Serial Paging.	Correct Serial Paging.
Agricultural Ledger, 1905—No. 1 . .	231—240	1—10
" " 2 . .	241—246	11—16
" " 4 . .	247—268	17—38
" " 5 . .	269—280	39—50

N.B.—With Agricultural Ledger No. 13 of 1904, was completed the first volume of the Vegetable Product Series, comprising pages 1—554.

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AGENTS.

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(Vegetable Product Series, No. 89.)

THE

AGRICULTURAL LEDGER.

1905—No. 1.

SCHLEICHERA TRIJUGA.

KUSUM TREE OF INDIA.

[*Dictionary of Economic Products, Vol. VI.*, S. 950-958.]

Paka seeds as the source of Macassar oil.

By DAVID HOOPER, F. I. C., F. C. S.

INTRODUCTION.

At the instigation of Mr. I. H. Burkill, Officiating Reporter on Economic Products to the Government of India, an enquiry was made in 1903 into the distribution and possible trade in the products of the *kusum* tree. It had recently been discovered that there was an extensive demand from abroad for the seeds, and the Forest Department was asked to take the opportunity to ascertain from local sources the actual uses and value of the tree.

Enquiry by Forest Department.

The Inspector-General of Forests accordingly addressed the following letter to all Conservators :—

"My attention having been drawn to the possibility of a trade being established in the seeds of the tree known as Schleichera trijuga which is believed to be the original source of Macassar oil, I have the honour to request that you will be good enough to favour me with a report on the following points :—

1. Is Schleichera trijuga found in your circle?
2. Is any use made of the seeds at present?
3. Supposing a demand were to arise for the seed, what amount would be available, and at what approximate cost?
4. In districts where the lac insect is extensively found upon Schleichera trijuga, is a trade in both products—seed and lac—compatible.
5. To what extent does the habit of lopping off branches to feed cattle interfere with the fruiting of the tree?"

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SCHLEICHERA trijuga.

Paka seeds as the source of

The replies of the Forest Officers were of great value, and the Inspector-General having courteously placed them at the disposal of the Reporter, they have been embodied with other material in the present Agricultural Ledger.

Schleichera trijuga, *Willd.; Fl. Br. Ind. I., 681.*, SAPINDACEÆ.

THE LAC TREE OR KOSUMBA; THE CEYLON OAK.

Vernacular.

Vern.—*Kosum, kusum, gausam,* HIND.; *Puvatti,* KADERS.; *Baru,* SANTALI; KOL.; *Kosum, kohan, koshimb, peduman,* MAR.; *Kosum, kocham, kosumb, gosam, assumar,* GUJ.; *Komur, pusku,* GOND.; *Rusam,* URIYA; *Kussam, kojba,* C. P.; *Samma, jamoa, gausam, kussumb,* PB.; *Pava, pu, pulachi, zolim buriki, pumarum, pularari, puva,* TAM.; *Pusku, posuku, pusi, may, mayi, rotanga, roatanga,* TEL.; *Sagdi, sagade, akota, chakota,* KAN.; *Chendala,* COORG; *Puva,* MAL.; *Gyo, kyetmouk, kobin,* BURM.; *Kon, kong, conghas,* CING.

Kusum is the Hindustani name for the Safflower plant, and perhaps refers to the colouring matter of the lac-insect which often feeds upon the tree. The seeds are called *paka* or *pacca* in Calcutta.

Habitat.

Habitat.—"Dry, chiefly deciduous forests in the greater part of India, Burma, and Ceylon, but apparently absent from Bengal and Assam. It is found from the Sutlej to Nepal in the lower Himalaya, Sub-Himalayan tract and Siwalicks up to 3,000 feet, throughout Central India, the East and West coast regions, the Deccan and Carnatic, in all deciduous forests throughout Burma and in the low country of Ceylon up to 2,000 feet." (**Gamble,** *Manual of Indian Timbers,* 2nd ed. 195.) The tree is not wild about Calcutta, but seeds abundantly in cultivation, and the seeds falling to the ground come up freely. The tree may therefore be said to be found over the greater part of India, excluding the following localities: Ajmer-Merwara, Baluchistan, Sind, North-West Frontier Province, Assam, and the Andaman Islands.

The circular note sent to Forest Officers by the Inspector-General in 1903 has resulted in fixing somewhat more definitely the actual distribution of the tree throughout India.

Bengal.

Bengal.—The tree occurs in Santal Parganahs, Palamou, Singbhum, Angul and Puri divisions. Samples of oil in the Indian Museum were received from Palamou and Angul divisions.

United Provinces.

United Provinces.—It is uncommon in the Oudh Circle, but common in the hilly *sál* forests of the Gurwhal division, and in the hills of the Ganges division from the Ganges to the Ramganga river.

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Habitat.

Its occurrence is also reported from the School Circle including Dehra Dun, but throughout the provinces it only grows sporadically and is not generally found in groups.

Central Provinces.

Central Provinces.—It is found in all the hill forests of the Berar Circle, and in all the districts of the Southern Circle, but it cannot be said to be plentiful except in the Raipur district, and fairly plentiful in the Bilaspur district.

Panjab.

Panjab.—**Schleichera trijuga** occurs only in the Kalesar range, Simla division, and there only in small quantities.

Bombay.

Bombay.—The tree is found in the Northern Circle, widely scattered, though not in abundance, throughout the Thana district, Surat and the Dangs, and in small quantities in the Panch Mahals. In the Central Circle it occurs at Khandesh and along the Ghat line of Nasik, Poona, and Satara. In the Southern Circle it is fairly common in the Kanara forests, and to a small extent in the Kolaba district.

The tree is found all over Coorg.

Madras.

Madras.—Reports show that it is fairly abundant in Ganjam. It is fairly abundant in the Rampa territory in Godaveri, but sparingly in the reserved forests; the species is also found in the Agency tracts, including Bhadrachellam sub-division. In Coimbatore it is scattered through the country, more commonly on the banks of rivers. It is widely distributed in the Nudumalai range and along the margin of streams in the Seegar range in the Nilgiris. In North Malabar it is found in fairly large quantities in the Begur and Chedlik ranges, and South Malabar in the Palghat range. Anantipur and South Canara produce it to a trifling extent. It is found in small numbers in Ghat forests in the Nangemeri, Ambasamudran, and Courtallum ranges in Tinnevelly. There are only one or two localities in the Central Ciricle, Madras, where the tree grows, and it never attains a great size.

Travancore.

Travancore.—The tree occurs at the foot of the hills and on their lower slopes. It is extensively planted along road sides, but nowhere occurs in great abundance in a wild state.

Burma.

Burma.—With the exception of South Tenasserim, **Schleichera trijuga** is fairly plentiful in all the divisions of the Tenasserim Circle, and it is fairly common in Pegu. From Upper Burma the Conservator reports a fairly plentiful occurrence in the Chindwin Valley, but a scarcity elsewhere in the Northern Circle. It is fairly common in many of the forests of the Southern Circle, particularly in the Madaya and Ruby Mines forests and Shan States.

The tree is distributed to Java and Timor.

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SCHLEICHERA trijuga.

Paka seeds as the source of

Macassar oil.

Macassar Oil.

A preparation for the hair has been known since the early Victorian era, as Macassar Oil, against which the common and old-fashioned Anti-macassar was originally intended to protect couches and chairs, but its origin has for many years been carefully guarded as a secret. The name Macassar was probably derived form the fact that the seeds yielding the oil came originally from the Malay Archipelago. *Mangkasar* is a Malay term properly applied to the name of a people inhabiting the Celebes, although it is now the name of a Dutch seaport in the island. In the 16th and 17th centuries Celebes was called by European writers the Isle of Macaçar or Mangasar. A recent visitor reports that after considerable enquiry he finds that as far as he can discover in Macassar at the present time there is no special kind of oil either produced or prepared.

Macassar hair oil is made up now according to many fancy receipts. In America an oil of the name is merely a solution of Ylang Ylang oil (Cananga odorata) in Cocoa-nut oil.

Trade in Germany.

According to the trade reports of Messrs. Gehe & Co. of Dresden, published in 1887, the oil of Schleichera trijuga appeared to have recently entered into the German market under the name of Macassar oil and was said to prove a very efficient and stimulating agent for the scalp both cleansing it and promoting the growth of the hair. The oil seeds were derived from the East, but no definite information could be discovered regarding the actual source of the seeds or the extent of the trade in them.

Trade in Calcutta.

In June 1903 a firm of merchants in Calcutta sent some of the seeds of the tree to the Reporter on Economic Products for identification. It was reported that they were called *pacca* in the vernacular and were brought from Orissa by the *Marwarees* during the months of June to September. The quantity obtainable during the previous years had been about 150 tons a year, and it was stated that the bulk of the supply was sent to Germany. They were recognised as the seeds of the *Kusum* tree from their characters which are described below, and experiments were made with the seeds and oil to confirm the results of the investigations which have been conducted on the Continent.

Possible Trade Sources.

Possible Trade Sources.

The Inspector-General of Forests supplied valuable information regarding the prevalence of the tree and possible commercial sources of the seeds.

The following replies were given to the question, "What amount is available in your circle and at what approximate cost?"

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Possible Trade Sources.

Bengal—Singbhum.—Possible yield per year 3,355 maunds at a cost of R1-2 to R3-4 per maund.

United Provinces.—School Circle.—The cost of collecting would be 3 annas per seer.

Oudh Circle.—100 maunds at R2 per maund.

Central Circle.—15 to 20 maunds at a cost of 2 to 8 annas a seer.

Central Provinces—Northern Circle.—600 to 700 maunds a year at R2 to R3 per maund.

Central Circle.—Raipur 13,000 maunds at 10 annas per maund.

Bilaspur.—200 maunds. R3 cost of collecting and carriage to the station.

Berar.—The cost of collecting would be 1 to 2 annas per seer, every four or seven years, when the fruit is abundant.

Bombay—Northern Circle.—Impossible to estimate the amount of seed available. A few tons might be collected at about R40 per ton.

Southern Circle.—About 200 maunds of 80lbs. each could be collected for export in Kanara and 4 maunds in Kolaba. The cost of collection and delivery on the railway would be between R4 and R5 per maund.

Coorg.—The estimated outturn is 2 tons at R40 per ton.

Madras—Ganjam.—During an abundant year the seed could be delivered at Berhampur at R1 per maund.

Godaveri.—Price of seed R2 a bag of 164 lbs.

Anantapur.—200 seers could be gathered at a cost of R4.

North Malabar.—On alternate years, when the trees fruit freely, 40 maunds of 28 lbs. of seeds could be supplied at 8 annas per maund.

South Malabar.—The estimated yield of the circle is 250 powas at 6 to 7 annas a powa of 6 Madras measures.

Nilgiris.—10 to 15 tons at R30 per ton.

North Coimbatore.—500 maunds or 6 tons at R10 per maund

South Coimbatore.—one ton for R150.

Tinnevelly.—3,000 measures at 9 pies per measure.

Burma—Tenasserim Circle.—200 bags equal to 600 baskets of seed could be supplied a year, at an approximate cost of R6-8-0 per bag F. O. B., Rangoon or Moulmein.

Pegu Circle.—A mere estimate is 5,000 lbs. a year at a cost of six annas per maund.

Upper Burma—Northern Circle.—400 bushels could be procured at R1-8-0 per bushel.

Southern Circle.—Large quantities would in a good seed year be procurable, but the cost would vary greatly from place to place.

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Possible Sources of Trade.

In the Ruby Mines district it is reported that considerable quantities of seed could be delivered on the Irrawaddy at R4 a basket of 1½ cubic feet, and from the Mandalay division it could be delivered at Kyaukse, Mandalay or Meiktila railway stations at R3 a basket.

It is seen that a large quantity of seed is available in India, but owing to the seed being edible, jungle tribes would in times of scarcity gather the fruits for their own consumption rather than for purposes of trade. We are told by some of the Forest Officers that monkeys and parrots are partial to the seeds, and these would have to be reckoned with in many districts when estimating a crop.

Effect of lac cultivation.

A good quality of lac infests the branches of the tree to a considerable extent in Raipur and Bilaspur in the Central Provinces. In the United Provinces it is occasionally found on the trees. In Bombay it is rare, and in Madras no lac trade is reported and no insects are noticed. Lac cultivation is a very exhaustive drain upon any tree and is incompatible with the exploitation of the fruit. In other words a successful outturn of lac would mean a very poor crop of fruit. Where the lac-insect does not attack all the trees of a district it is not unreasonable to expect a harvest of seed as well as lac.

Effect of lopping.

With regard to the lopping of branches for fodder and its effect on the yield of fruit Forest Officers are almost unanimously of opinion that this practice interferes with the fruit-bearing capabilities of the tree. It has been noticed in Oudh that trees on private lands where leaves and branches are taken for fodder produce no seed. The fruits are usually produced at the ends of the branches as in other plants of the Sapindaceæ family, and it consequently follows that the custom must seriously interfere with the yield. During a time of drought the trees are severely lopped in the Panjab and no fruit is available during the year. If the lopping is done in February-March no seeds can be expected for one or two years afterwards, but in about two years the trees recover. In Garhwal it is said that the pruning of small branches within reasonable limits would probably not affect the amount of seed produced, but here as elsewhere severe lopping would certainly do so.

Uses of the oil and seeds.

USES OF THE OIL AND SEEDS.

The inhabitants of the villages and aborigines of the forests use the oil for ordinary domestic purposes. As an illuminant and for cooking it is employed in Bengal, Bombay, Burma, Madras, Travancore, United Provinces and Central Provinces, as a hair oil in the United Provinces and Dangs of Bombay.

In the Nilgiris the oil is used for anointing the body. The medicinal effects are variously reported as purgative (in the United

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USES OF THE OIL AND SEEDS.

Provinces) and as prophylactic against cholera (in Thana division, Bombay). It is more usual to apply it externally in massage for rheumatism (Bombay), for the cure of headache (Sambalpur, Central Provinces). Its application in Bombay, Malabar, and Coorg is said to be effective in removing itch and other forms of skin diseases, and this remedy is known to the wild forest tribes. The powdered seeds are applied to ulcers of animals and for removing maggots.

No oil is sold or exported in any of the districts.

Notwithstanding the peculiar taste of the ripe fruits and seeds they are eaten by local tribes of the United Provinces, Central Provinces, Bombay (Bhils and Panch Mehals), Burma (Tenasserim), Madras (Coimbatore). In Berar the seeds are regularly eaten, and largely consumed in times of scarcity or famine.

The Seeds.

The seeds.

The seeds are ovoid or rounded in shape, about five-eighths of an inch long by half an inch broad, smooth, reddish-brown in colour, and marked with an indented hilum at one end. One hundred seeds weigh 57 grams giving an average weight of 8·7 grains per seed. On removing the brown, brittle shell a dirty white kernel is disclosed with white markings on the testa. One hundred parts of seeds afford 66 parts of kernels and 34 parts of shells. The kernels extracted with ether or petroleum spirit yielded in the Museum laboratory 61·4 per cent. of oil, showing that the entire seed contains 40·5 per cent. of oil.

Mr. J. H. Walker of the Oil Department of the Gouripore Company, Naihati, obtained a yield of 60·4 per cent. of a thick fixed oil from the kernels, which is equivalent to 36·7 per cent. on the nuts.

Composition of seeds and oil.

COMPOSITION.

The first analysis of the seeds appears to have been made by Dr. L. Van Itallie [*Apoth. Zeitung.* (1889), 4·506], who separated about 36 per cent. of a buttery fat, which he called the Macassar oil of commerce. It had a specific gravity of 0·924 at 15° C., melted at 28° C., had an iodine number of 53, a saponification equivalent of 219 (1 gram required 230 mgm. of potash for saponification), contained 91 per cent. of insoluble fatty acids and 6·3 per cent. of glycerol. The fatty acids present included acetic, butyric lauric, arachic and oleic acids.

Van Itallie's analysis.

The next recorded analysis of Macassar oil is that of Dr. K. Trümmel [*Apoth. Zeitung.* (1889), 4·518]. The oil had a melting point of 21°-22° C. The presence of hydrocyanic acid was detected and 0·47 per cent. obtained by steam distillation. Benzaldehyde

Trümmel's analysis.

COMPOSITION.

was detected in the distillate by its transformation into benzoic acid by the action of potassium permanganate.

Dr. Trümmel in conjunction with Mr. Kwassick further investigated the oil in 1891 (*Pharm. Zeit.* May 1891, 314), after confirming previous results the authors separated the constituents of the oil. The fatty acids, with the exception of 3·15 per cent. of free oleic acid, were present as glycerides. Of these in combination 70 per cent. consisted of oleic acid, and of the solid fatty acids 5 per cent. was palmitic and 25 per cent. arachic acid, the characteristic acid of the ground-nut. Lauric acid was not present, and of the volatile fat acids only acetic and no butyric acid could be detected. Hydrocyanic was found in the oil and in the seeds, being determined as 0·03 per cent. in the former and 0·62 per cent. in the latter. No amyadalin could be detected in the seeds, but hydrocyanic, benzaldehyde and grape sugar, possibly the decomposition products of it, were found. A small quantity of cane sugar was also separated in the crystallised form.

Glenk's analysis.

In 1893 an examination was made by Mr. R. Glenk (*Amer. Journ. Pharm.* LXV. 528) of a specimen of the oil from seeds sent from Mirzapur. The oil was described as a yellowish-white semi-solid substance having a faint odour of bitter almonds and a specific gravity of 0·942. The oil had an acid re-action, and completely liquified at 28° C. It was readily saponified by sodium hydrate even at a low temparature, forming a white hard soap. Concentrated sulphuric acid acquired a reddish-brown colour on addition of the oil. It is soluble in chloroform, ether, bisulphate of carbon, benzene, and the fixed and volatile oils.

Wijs' analysis.

Dr. J. J. A. Wijs examined the seeds in 1900 (*Zeits. physic. Chem.* 31·255—257). The seeds of Schleichera trijuga were obtained from the Celebes, and 60 per cent. consisted of kernels. The kernels had the following composition:—

Water	3·5
Fat	70·5
Proteids	12·0
Fibre and ash	14·0
	100·0

The fat extracted by means of petroleum ether had the colour and consistence of butter. The following constants were determined: melting point (by the Le Sueur and Crossley method), 22° C.; melting point of the fatty acids, 52—54° C.; Hehner value, 91·55; saponification value (Henriques' cold process), 215.3; iodine value (Wijs' iodine chloride and acetic acid method), 55·0, that of the fatty

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COMPOSITION.

acids being 58·9; Reichert-Meissl value, 9; acid number, 19·2; acid number of the fatty acids, 191·2—192·0; unsaponifiable matter, 3·12 per cent. The volatile acids (acetic acid with a little butyric acid) were examined by the Duclaux method; and the ratio of the solid (45 per cent.) to the liquid fatty acids (55 per cent. with iodine value 193·2) was determined by the Rose method.

In the Indian Museum two samples of *Kusum* oil are exhibited; one was from Palamou and had been presented to the Agri-Horticultural Society of India in 1845, the other was from Goomsuti and was formerly the property of the Asiatic Society of Bengal. The oils had high acid values of 26 and 26, iodine values of 129 and 90·6 and melting points of fatty acids 35 and 36 respectively. A sample from Angul gave an acid value of 10·42, iodine value, 56; and melting point of fatty acid, 48. The samples had the odour of oil of bitter almonds notwithstanding the time they had been kept in the Museum.

Timber.

Timber.

The wood is hard, more or less bent, strong and durable. In colour it is light reddish-brown (heart wood) and whitish (sapwood). The timber is much used for making pestles, cart wheels, naves and axles, ploughs, and the teeth of harrows, also for rollers of sugar mills and of cotton and oil presses. Weight per cubic foot 70 lbs.

A fitting conclusion to the information contained in the report will be found in the following note on the tree drawn up by the Inspector-General of Forests :—

Conclusion.

" The tree is only of local value at this moment. Before the introduction of the iron roller cane mills there was a very large export of the timber for sugar presses for which purpose its hardness and toughness suits admirably. Since that time, however, although the seeds are used for oil, the twigs for lac feeding, the flowers for dye, I believe, sometimes, the chief value of the tree has been lost. I have no doubt that these persons who use the oil do so because it happens to be to them the cheapest available, but not for any special quality."

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G. I. C. P. O.—No. 389 R. E. P.—30-5-1905.—2,500.—R. T. C. D.

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1905—No. 2.

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(Vegetable Product Series, No. 90.)

THE AGRICULTURAL LEDGER.

1905—No. 2.

PHASEOLUS LUNATUS.

(LIMA OR DUFFIN BEAN.)

[*Dictionary of Economic Products, Vol.* VI, Pt. I, pages 489-492.]

A report on the Chemical examination of the beans, by WYNDHAM R. DUNSTAN, F.R.S., *Director of the Imperial Institute, London.*

The following information on this plant, gathered since the article on **Phaseolus lunatus** was written for the *Dictionary of Economic Products,* will be of some interest as an introduction to Prof. Dunstan's report.

Phaseolus lunatus, *Linn.* Lima or Duffin Bean.

Vern.—*Kursumbulle-pullie,* Hind.; *Bimbur-butti, ma,* Beng.; *Tik-bit-zim, kerow-simbi, lum takbit,* Sikkim; *Kataridabooa mah, bangala mah, urahi,* Ass.; *Udadyaweli,* Ali Rajpur; *Pegyi, pegya, pe-la-la, pe-saulagu,* Burm.; *Koro-mas,* Java.

Habitat.—The Lima bean is said to be indigenous to South America, but it has long been cultivated in most of the warmer parts of the earth. Bentham refers to wild specimens from the Amazon basin and central Brazil. They belong specially to the large variety (**macrocarpus**) which abounds in the Peruvian tombs of Ancon. It was probably introduced into Guinea by the slave trade and spread thence into the interior and coast of Mozambique. It is cultivated nearly throughout tropical Africa. However, Schueinfurth and Ascherson do not mention it for Abyssinia, Nubia, or Egypt. Habitat.

In India it is found in Assam, Bengal, Burma and the Panjab. It is a scanty bearer on the hills and plains of the United Provinces, and is not an established garden crop. It grows in Southern India, but is rarely met with.

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PHASEOLUS lunatus. A report on the Chemical

Habitat.

It has long been cultivated in Australia where it is known as the Dwarf or Bush Lima bean. In 1896 it was introduced into New South Wales from the Tonga Islands, and is known as the Tongan bean. It climbs to the tops of shrubs and trees and forms a pretty vine for covering trellis or out-houses. An interesting paper on the cultivation of the Bush bean will be found in the *Agricultural Gazette of New South Wales,* Volume III, Part II, 1892, 644. The Lima bean is also cultivated in California. Professor L. H. Bailey, of the Cornell University wrote an account of its cultivation and uses in 1896.

Uses.

Uses.—The legumes or pods of this plant are not used as an esculent. The ripe seed are eaten, and they should be cooked in a similar way to haricots or broad beans. When properly served up they are much superior to either of these pulses (Turner). It is used as a fodder plant by the natives of the Tonga Islands, and the white population appreciate the beans, which are cooked like French beans, or shelled like peas when nearly matured. The green pods may be picked, and the beans shelled out and dried, and these can be used in the winter time to as good advantage as if they were thoroughly ripe. If these dried beans are soaked in water for some time before they are cooked they are scarcely inferior to green beans direct from the vine (Bailey).

In Assam the seeds are eaten, either raw or fried in oil or boiled in water.

Chemical Composition.

Chemical Composition.

The composition of the beans is thus represented. The first analysis is that of a white seeded variety from Mysore made by Dr. Church, in 1886; the second is that of the seeds grown in Java made in the Haarlem Museum, Holland, in 1900.

	Mysore.	Java.
Water	13·3	14·85
Albuminoids	19·7	21·00
Carbohydrates	57·8	36·88
Oil	1·2	0·60
Fibre	4·3	3·66
Ash	3·7	3·38

The poisonous action of the seed has been observed for many years and fatal effects have often followed the consumption of the raw beans. Van Romburgh in 1897 (*Mededeelingen uits lands plantentuin,* Vol. 29, page 56) referred to their toxic nature in the island of Réunion. He stated that the seed contained an amygdalin like glucoside which on decomposition yielded 0·25 per cent. of hydrocyanic acid. The leaves also gave on distillation with water hydrocyanic or prussic acid and acetone.

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Chemical Examination.

Professor Dunstan's report will give the history of the investigations down to the present time. The paper is entitled :—

Report on the chemical examination of the Beans of **Phaseolus lunatus** grown in India, by Professor Wyndham R. Dunstan, M.A., F.R.S., Director.

Origin of poisonous property.

An investigation into the cause of the occasional toxicity of various fodder plants has been carried on in the Scientific and Technical Department of the Imperial Institute during the last few years. In the course of this work it has been shown that in a number of cases the poisonous nature of these materials is due to the presence of glucosides, which are decomposed by soluble ferments, also present in the plants, with the production of prussic acid, which acts as the poison. Full accounts of the chemistry of a number of these glucosides and of the reactions resulting in the formation of prussic acid from them have been given in the series of papers enumerated below, which have been communicated to the Royal Society by Professor W. R. Dunstan and Dr. T. A. Henry.

Previous papers.

No. 1. "Cyanogenesis in Plants. Part I. The Nature and Origin of the Poison of *Lotus arabicus*." Transactions of the Royal Society, 1901, 194 B, 515.

No. 2. "Cyanogenesis in Plants. Part II. The Great Millet. *Sorghum vulgare*." Transactions of the Royal Society, 1902, 199 A, 399.

No. 3. "Cyanogenesis in Plants. Part III. On Phaseolunatin or the Cyanogenetic Glucoside of *Phaseolus lunatus*." Proceedings of the Royal Society, 1903, 72, 285.

Copies of these papers have been sent to the Officiating Reporter on Economic Products to the Government of India, and an abstract of No. 3 has been published in India, as "Commercial Circular No. 2 of 1903," under the title of "Lima, Duffin, Rangoon, or Paigya Bean—**Phaseolus lunatus.**" In this Circular, attention is drawn to the desirability of ascertaining whether some varieties of this bean should be cultivated in India in preference to others.

Sorghum vulgare.

Reference may also be made here to the report dated the 19th January 1905, already sent to the Officiating Reporter on Economic Products, giving the results of the chemical examination at the Imperial Institute of a number of samples of Indian **Sorghum vulgare,** from the same point of view.

The first specimen of the beans of **Phaseolus lunatus** examined at the Imperial Institute came from Mauritius where the plant is grown in a practically wild state and used as a green manure. A number of cases in which cattle had been poisoned as the result of eating the plant had been recorded in Mauritius, and in 1898 Mr. Boname, Superintendent of the Botanic Station in the Island,

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Chemical Examination.

showed that the whole plant produced prussic acid when ground up in contact with water, the largest amount of the acid being obtained from the seeds, and that the toxicity was due to the formation of this substance.

The results of the investigation of the Mauritius beans at the Imperial Institute may be briefly summarised in the statement that they were shown to contain a cyanogenetic glucoside, to which the name *phaseolunatin* was given, and an enzyme probably identical with the *emulsin* of almonds. It was further shown that when these two substances were brought into intimate contact, *e.g.*, by grinding the beans with water, the glucoside was decomposed by the enzyme, yielding acetone, dextrose and prussic acid. The amount of prussic acid so obtainable from the Mauritius beans varied from 0·04 to 0·09 per cent. by weight, the largest quantity being found in the seeds having a dark purple-coloured testa and the smallest amount in those having a pale cream-coloured or almost white testa.

Cyanogenetic glucoside.

Phaseolus lunatus is generally stated to be indigenous to South America (whence the name Lima-bean by which the white bean, apparently produced only by carefully cultivated plants, is sometimes known) but it has been introduced into most tropical and sub-tropical countries and is widely grown for edible purposes throughout the East Indies.

White seeds preferred.

In partially or wholly cultivated forms the testa of the bean is either pink with a few purplish spots, pale cream-coloured or even quite white. These forms of the bean are undoubtedly less poisonous than the almost wild type grown in Mauritius, but even with the cultivated varieties cases of poisoning occurred and attention has been directed to their toxicity by various authors, thus **Watt**, *Dictionary of Economic Products of India*, Volume VI, I, 187, states that " It is well to remember that this species sometimes exhibits markedly poisonous properties," and **Church**, *Food Grains of India*, page 155, says : " This is one of the species of **Phaseolus** which sometimes exhibit marked poisonous properties. It is desirable that great care should be taken in selecting for cultivation only the best variety of Lima-beans. The large oval white-seeded kinds with, at the most, a brown or black mark at the hilum are preferable to those with flattened rather uniform seeds having blotches of red or veinings of black."

Burma beans.

Whilst the investigation of the Mauritius beans was in progress at the Imperial Institute there were imported into this country from India large quantities of beans variously described as Rangoon, Burma or Paigya beans intended for use in preparation of feeding-stuffs for cattle. Samples of these beans were sent to the Imperial Institute by a number of firms in various parts

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of the country with a request for information as to their identity and their suitability for use as a feeding-stuff.

Chemical Examination.

These beans closely resembled those produced by the semi-cultivated forms of **Phaseolus lunatus,** the testa varying in colour from white to pale pink with a few purple spots. They were chemically examined and it was found that the white beans, which were as a rule present only in small quantity, yielded no prussic acid, whereas the coloured ones yielded from 0·004 to 0·009 per cent. of the acid. Plants were eventually grown from some of these samples of Burma beans and were identified as **Phaseolus lunatus.**

No poison in white beans.

Preliminary accounts of these investigations on Rangoon beans were published in the "*Bulletin of the Imperial Institute,*" Volume 1, 1903, pages 16 and 115, and, in these articles attention was directed to the fact that although the amount of prussic acid obtainable from the coloured beans was in most cases probably insufficient to be dangerous to cattle, yet in view of the fact that the amount of the acid formed varied with different specimens of seed, it seemed desirable that the use of this material as a feeding-stuff should be attended with caution until it had been ascertained precisely under what conditions it was poisonous.

A food for cattle.

In the meantime application had been made in a letter, dated the 18th December 1901, to the Reporter on Economic Products to the Government of India for authentic samples of the beans of **Phaseolus lunatus** grown in India so that the investigation carried out with the Mauritius beans might be repeated on this material. In compliance with this request a sample of these beans was sent to the Imperial Institute by the Officiating Reporter on Economic Products under cover of a letter (F. S. 2987—144), dated the 11th December 1902.

Indian seeds.

This sample was examined in the Scientific and Technical Department of the Imperial Institute and gave the following results.

Description of sample.

The sample was labelled "**Phaseolus lunatus** beans from Pokakku District, Burma." The beans were light brown in colour with a few purple spots and closely resembled the Burma or Paigya beans imported into this country.

From Burma.

Results of Chemical Examination.

The amount of prussic acid yielded by the beans was determined by grinding them into a fine powder and extracting this with alcohol, in which the glucoside is soluble and the enzyme insoluble. The alcohol was then distilled off and the glucoside, left in the residue, was decomposed by boiling it with hydrochloric acid. The prussic

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PHASEOLUS lunatus. **A report on the Chemical Examination of the Beans.**

Chemical Examination.

acid so produced was distilled off and estimated. It was found as the mean of a number of experiments carried out in this way that this sample of beans yielded 0·039 per cent. of prussic acid. Along with the acid, acetone was invariably found in the distillate, and the simultaneous presence of both these substances left little doubt that the seeds contained phaseolunatin.

General Conclusions and Recommendations.

Conclusions.

These results show that although the seeds of **Phaseolus lunatus,** as grown in Burma furnish less prussic acid than those produced in Mauritius, they still yield a sufficiently large proportion of this poison to render them undesirable for consumption, at any rate in the raw state.

It has been urged that the quantity of prussic acid produced by these semi-cultivated varieties of Burma beans is so small that they may be regarded as innocuous. It is impossible to say without actual trial whether the continuous consumption by animals of material yielding a small amount of prussic acid would be injurious or not. Apart from this difficulty there is the possibility of great variation in the amount of prussic acid produced by these beans. Experience with the Mauritius beans has shown that the amount of prussic acid obtainable may vary widely, and in the more limited experience with the Indian beans similar variations have been observed. Since the causes of these variations are at present unknown and therefore uncontrollable, it is possible that as the result of some slight change in the method of cultivation or under abnormal climatic conditions, the quantity of prussic acid obtainable from these semi-cultivated seeds from Burma might give rise to amounts of the poison corresponding with those obtained from the light coloured Mauritius varieties, as to the toxicity of which there can be no question.

Prussic acid variable.

The Indian trade in leguminous seeds suitable for feeding-stuffs is already large and is steadily increasing, and it is therefore necessary for those concerned in the export of these commodities to exercise care in selecting new grains for export.

Selection.

It is obvious that much harm would be done to this branch of Indian trade if by any chance consignments of poisonous beans were exported and distributed in the ordinary way.

White beans to be cultivated.

It seems advisable therefore that if possible the cultivators of this material for export should be advised to cultivate the perfectly white beans rather than the coloured varieties, which are now shown not to be above suspicion.

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G. I. C. P. O.—No. 811 R. E. P.—11-7-1905—2,500.—J. W. G.

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SALTPETRE.

(NITRE, POTASSIUM NITRATE.)

[Dictionary of Economic Products, Vol. VI., Pt. II., S. 681-704.]

A REPORT ON THE MANUFACTURE AND COMPOSITION OF INDIAN SALTPETRE, BY DAVID HOOPER, F.I.C., F.C.S.

Introduction.

The Inspector General of Agriculture in India in 1902 instituted an enquiry regarding the distribution of nitre deposits in India and the methods of manufacture adopted in separating and refining the salt. This was undertaken to show ways and means of reducing the cost of this salt so as to permit of its being used more extensively as manure either as crude saltpetre or in a purer form. The following notes on the subject are drawn up from observations made in the saltpetre-bearing districts, and from information obtained from officers of Salt, Revenue and Agricultural Departments.

It is desirable first to explain the process of nitrification with special reference to this country. The districts where nitre earths occur and where the salt is manufactured are then enumerated. The manufacture of saltpetre is described, and tables are given of the analyses of numerous samples of nitrous earth, crude and refined saltpetre, impure and purified table salt and other by-products.

Nitrification.

Nitrification.

It has long been known that when animal and vegetable matters containing nitrogen decay in earth impregnated with wood-ashes or lime, nitrates of potash and lime are formed. In warm climates especially there are numerous localities where the soil is highly charged with nitrates. This is not only true of India but of Egypt,

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Nitrification.

Poland, Hungary, Italy, Turkey, Burma, Tibet, Turkistan, Sumatra and Brazil. In each of these countries earths occur which are rich enough in saltpetre to pay the cost of working. In all these places the nitrate of potash appears to have resulted from the decomposition of organic remains, and is found chiefly on the sites of former habitations. The water of wells in crowded cities usually contains nitrogenous compounds originating from the soil and subsoil being contaminated with sewage and other nitrogenous organic matter. The nitrification occurs in the surface soil in contact with air and in the presence of an alkaline base such as lime, magnesia, potash, or soda. Usually there is enough carbonate of lime in soils to promote the action. Schlossing, performing some careful experiments in this subject, found that ammonia mixed with moist loam changed completely into nitrates in a fortnight. The processes of nitrification are caused by microscopic organisms termed bacteria or bacilli. One class of bacteria, according to Winogradsky, converts the ammonia into nitrous acid and are called nitrous ferments, and the other changes nitrous acid into nitric acid and are termed nitric ferments.

The following are some of the more important conditions favourable to the work of the nitrifying bacteria :—

Temperature.

(*a*) *Temperature.*—The formation of nitrates becomes active at 54° F., and increases as the temperature rises above that point until it reaches 98° to 99° when nitrification is at its maximum. Under suitable conditions, other things being equal, 10 times as much saltpetre can be obtained at 99° as at 54°.

Moisture.

(*b*) *Moisture.*—Water is indispensable in the formation of nitrates. Drought will retard the process, and severe drought stop it. Absence of rain for two or three seasons in certain Panjab saltpetre districts has caused a short supply. Water conveys the potash and lime bases to the scene of action where the bacteria are at work. It holds saltpetre and other salts in solution, and as it evaporates throughout the hot season brings these salts to the surface of the soil.

Oxygen.

(*c*) *Oxygen*—Is essential, hence air must gain free admission to the surface soil as the process goes on. In the refineries the caking mud caused by throwing the dissolved by-products on the earth is broken up to allow of sufficient aëration.

Darkness.

(*d*) *Darkness*—Is believed to be favourable for the formation of saltpetre. In manufactory yards in India the nitre earth is kept in sheds ; this is not only to keep off the rain but the

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Nitrification.

refiners believe that darkness produces a better yield of saltpetre.*

Lime.

(*e*) *Calcium Carbonate* or lime aids the process. It was found present in all the samples of nitrous earths recently examined, and in considerable quantity in some samples.

Indian Nitre-bearing localities.

Nitre-bearing localities.

The districts where nitre or saltpetre is chiefly found occur in the Indo-Gangetic tract, which is identical with the geological region known as Indo-Gangetic alluvium. Beyond the Indus, in the Panjab, nitre is obtained from Bannu and Dera Ghazi Khan. Between the Jhelum and the Sutlej it is derived from Shahpur, Gujrat, Multan, Gujranwala, Montgomery, and Lahore, and on the other side of the Sutlej in Gurgaon and Karnal, at Hissar, Rohtak, and Delhi. In the United Provinces of Agra and Oudh it is found in the districts of Farukhabad, Mainpuri, Aligarh, Budaun, Hardoi, Meerut, Muttra, Etah, Etawah, Agra, Jalaun, Cawnpore, Hamirpur, Fatehpur, Allahabad, Benares, Ballia, Gorakhpur, Azamgarh, Mirzapur and Ghazipur. In Bengal it occurs chiefly in the Bihar districts of Saran, Champaran, Muzaffarpur, Darbhanga and Monghyr. Kashmir and the Native States of Patiala and Rampur furnish small supplies. It has also been collected in the Chanda districts of the Central Provinces, in the Ahmedabad and Kaira districts of Bombay, in Sind, in Bhino Jwargan in Central India, and in parts of the Deccan. Small quantities occur in Coimbatore, Kistna, and Trichinopoly in the Madras Presidency. In Burma saltpetre has been manufactured between Pagan and Ava on the Irrawaddy, and in the Southern Shan States. (*Ind. Forester*, XXVII, 1901, 582.)

The formation and composition of nitrous earth.

Formation of nitrous earth.

In the places where the nitrous earth is collected the natural vegetation is scant.† The soil of the more open parts is too salt for agricultural crops even in the rains. Nitrous earth to a considerable extent is obtained from places which could not be cultivated. It is obtained in and around existing village sites and on mud walls which enclose the dwelling places and cow-sheds of the village. In the rainy season, lasting from June to October, the process of nitrification

* Heat of the sun is necessary for the formation of saltpetre. In manufactory yards in India the nitre earth is kept in sheds to prevent the saltpetre from being washed out of it by heavy rainfall. After the monsoon the nitrous earth is brought out of sheds and its cultivation is carried on in the open air. In districts of heavy rainfall like Bihar the nitrous earth is kept under shelter. (*Comr., N. I. Salt Rev.*)

† The nitre-bearing land at Hansi produces the *ak* (**Calotropis procera**), *karil* (**Capparis aphylla**) and the Mexican poppy (**Argemone mexicana**). It is of interest to notice that Mr. J. O. Schlotterbeck has recently made a chemical investigation of the Mexican poppy in America and he reports (*Journ. Amer. Chem. Soc.* 24,242) that potassium nitrate is present in the ash of the plant in notable quantity.

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Nitrous earth.

goes on in the warm moist surface soil, to which conservancy refuse and other nitrogenous organic matter has been added. The soil's natural supply of necessary inorganic bases is increased by the people throwing fuel ashes outside their dwellings. During the dry season, commencing in November, the soluble products of the nitrifying bacteria rise to the surface by capillary attraction. This nitrous earth differs from the white *reh* efflorescence so commonly seen in the United Provinces and the Panjab. It is of darker colour, and if scratched with a nail or knife white specks of nitre crystals are visible to the naked eye, and the earth, if placed on the tongue, has a cool, saline taste. This incrustation with the soil to the depth of half an inch is the nitrous earth or *lunamati* or *mitishora* of Indian saltpetre manufacturers.

Composition of nitrous earth.

Analyses of the nitrous soils of the Hathwa Raj, Bengal, were made from month to month from February to May and were found to have a similar composition. This indicates that in this district the constituents remain the same during the continuance of the dry weather. Another series of analyses was made of soils taken at various depths immediately after the rainy season. A complete analysis being made of each sample, it was shown that the soluble salts, of which potassium nitrate was the most abundant, existed in a larger amount above 6 inches below the surface of the earth. The nitrates rise to the surface after a short time, but at the depth of 12 inches at two different sites there was no indication of nitrates and an almost entire absence of other soluble salts. Lime and phosphoric acid were noticeable in all the soils, but organic matter and ammonia were in small amount.

The two sub-joined columns give the analyses of nitrous soil from Bengal. The first was made by the author and the second by Drs. Boekhout and Otto de Vries, of the Rijkslandbouwprefstation, Hoorn, Holland.

Water	9·04	3·3
Organic matter	6·22	·5
Iron oxide	3·52	4·0
Alumina	3·82	8·0
Lime	5·67	9·7
Magnesia	·86	...
Potash	1·87	1·0
Soda	1·26	1·7
Phosphoric acid	·22	·26
Sulphuric acid	·97	2·3
Chlorine	·30	·8
Nitric acid	2·00	*
Carbonic acid	3·83	...
Silica and sand	60·40	50·8

* Total nitrogen 0·29 (Jodlbaur), 0·30 (Dumas), nitric nitrogen 0·22, albuminoid nitrogen 0·08 per cent.

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Nitrous earth.

Seventy-two samples of nitrous earth were chemically examined. The results are exhibited in tabulated Statement I which discriminates between various classes of samples. The composition of the samples is exceedingly variable. The salt consist of nitrates, nitrites, chlorides and sulphates of potassium, sodium, magnesium and calcium. They have an alkaline reaction, and in a few cases evolve a slightly ammoniacal odour. The two samples, Nos. 96 and 97, from Cawnpore, and one, numbered 421, from Lahore, were not used for saltpetre making but for manures in gardens. Nitrous earth is not uncommonly used as manure in parts of the Panjab, United Provinces, Sind, and Bengal. The particular samples referred to are superior for nitre production to some others in the tabulated list, but could have only been economically used locally as manure. The cost of transport to any distance would have been prohibitive, as they only contained about half the amount of nitrogen found in ordinary samples of farmyard manure.

Valuation.

The total percentage of salts in the various samples varies from 36·22 to 1·49, whilst the percentage of nitrates varies from 22·57 to ·64. The true value of a nitrous soil to the saltpetre manufacturer depends more upon the quantity of nitrates in the salts than on the salts in the soil. An effort was made to obtain, from each locality, samples which in local opinion were considered good, middling, and inferior. These particular samples are grouped in the statement collectively. Actual analysis showed that in some cases local opinion was right, in other instances it was very wide of the mark. In the light of this evidence we are led to the conclusion that the value of nitrous earth cannot be estimated merely by its appearance.

As regards the earths from Okara in the Panjab, the local valuation was right. The samples yielded of potassium nitrate—

	Per cent.
Good	12·58
Middling	6·10
Inferior	3·81

In samples from Farukhabad, Bhawani, and Sirsa the supposed superiority is attributable more to the abundance of the saline matter than to the yield of nitrates. As regards samples from other districts those which were classed as inferior or middling were actually found superior to those appraised as good.

There is clear evidence that the nitrous earths obtainable in some districts are of high value for the production of excellent saltpetre, and are very much superior to those found in other districts. Fuller enquiry is required to determine relative values in a reliable way, and also differences in value between samples of the same districts collected at various times during the manufacturing season.

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Nitrous earth.

Samples 542 to 558, which form the fourth group of the tabular statement, were collected to throw light on the latter point, but the figures are contradictory and do not exhibit any progressive increase or decrease of value.

It should be noticed that nitrous earth frequently contains stones and pieces of broken pots, etc., owing to the fact that it is collected mostly from the sites of old habitations. The larger pieces are removed by the worker because they interfere with filteration. Samples 434 and 457 were of this class. The analyses 434 A and 457 A represent that of the finely sifted earth removed from the coarse impurities of the original samples.

Factory soil.

Samples 64 to 72 of the 5th and 6th groups of the statement represent " Refinery earth " or " Factory soil," and these should be distinguished from ordinary nitrous earth. The manufacturer spreads his exhausted nitrous earth in his yard, and on it are thrown from time to time the skimmings from the boiling saltpetre solution, such mother-liquor as can be spared or is supersaturated with inferior salts, the ashes from the fire-places, and all other waste products from the factory. These are absorbed by the soil of the yard which is stirred to secure admixture and aëration. The samples of factory and refinery earths were obtained from these yards. Some of the samples were collected in the open yards, others in closed sheds. They are naturally of variable composition.

STATEMENT I.—*Analyses of nitrous earths.*

Serial No.	Source of Sample.	Register No. of sample in the office of the Agricultural Chemist.	Nitrates of Potassium, Lime and Magnesium.	Chloride Sodium.	Sulphate Sodium.	Total Salts.	Nitrogen in Nitrates.	REMARKS.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1	Cawnpore	96	3·60	1·99	1·95	7·54	·49	Nitrous earth directly used as manure.
2	"	97	2·29	2·85	3·60	8·74	·33	
3	Lahore	421	2·67	4·82	5·02	12·51	·45	
4	Shahawar, Etah, good	432	6·28	2·01	·97	9·26	1·00	Nitrous earths from various districts classed locally as good, middling, inferior, or 1st, 2nd, and 3rd quality.
5	" " middling	433	9·49	2·42	1·17	13·08	1·43	
6	" " inferior	434	1·17	·50	·50	2·26	·16	
7	" " "	434a	1·86	1·00	·78	3·64	·27	
8	Muttra, good	457	2·96	1·50	·90	5·36	·46	
9	" "	457a	6·04	2·73	1·29	10·06	·90	
10	" middling	458	6·65	5·35	·98	12·98	·97	
11	" inferior	459	9·08	4·20	1·32	14·60	1·33	
12	Sewan, Saran, good	649	7·11	3·85	·50	11·46	1·23	
13	" " inferior	650	2·80	1·38	1·45	5·63	·50	
14	Hardoi, quality I	871	4·68	4·35	4·05	13·10	·79	
15	" " II	872	7·68	7·06	3·98	18·72	1·22	
16	" " III	667	4·59	5·18	5·44	15·21	·80	
17	Farukhabad, quality I	672	7·48	11·67	10·17	29·32	1·27	
18	" " II	875	7·42	10·67	8·79	25·88	1·21	
19	" " III	673	3·32	4·22	5·24	12·78	·57	
20	Gurwa, Ghazipur, good	677	9·41	5·26	·59	15·26	1·58	
21	" " middling	678	13·95	4·48	2·15	20·58	1·30	
22	" " inferior	679	12·39	3·80	1·95	18·14	2·10	
23	" " good	683	2·01	1·03	1·36	4·40	·33	

STATEMENT I.—*Analyses of nitrous earths.*

Serial No.	Source of Sample.	Register No. of sample in the office of the Agricultural Chemist.	Nitrates of Potassium, Lime and Magnesium.	Chloride Sodium.	Sulphate Sodium.	Total Salts.	Nitrogen in Nitrates.	REMARKS.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
24	Gurwa, Ghazipur, middling	684	4·59	4·34	·59	9·52	·76	Nitrous earth from various districts classed locally as good, middling, inferior, or 1st, 2nd, and 3rd quality.
25	" " inferior	685	·64	·14	·71	1·49	·11	
26	Okara, Montgomery, good	715	17·87	8·03	5·94	31·84	2·66	
27	" " middling	716	9·08	7·36	2·60	19·04	1·36	
28	" " inferior	717	9·60	10·15	3·73	23·48	1·56	
29	Bhawani " good	725	29·57	10·78	4·87	36·22	3·06	
30	" " middling	726	6·89	4·66	7·77	19·32	1·10	
31	" " inferior	727	3·73	4·17	5·04	12·94	·59	
32	Sirsa, Hissar, Panjab, good	733	6·66	6·84	4·40	17·90	1·02	
33	" " " middling	734	8·04	5·45	·65	14·14	1·23	
34	" " " inferior	735	4·53	1·82	1·45	7·80	·71	
35	Bhera, Shahpur, Panjab, good	740	13·08	14·26	6·46	33·80	2·28	
36	" " " middling	741	9·92	9·31	2·63	21·86	1·60	
37	" " " inferior	742	2·41	1·82	1·76	5·99	·41	
38	Muswanpur	381	6·93	2·24	·57	9·80	1·08	
39	Jajmou	383	2·75	2·21	2·62	7·58	·42	
40	Hansi	435	4·25	2·27	1·12	7·64	·70	
41	Hansi Castle	439	3·99	1·73	·60	6·32	·60	
42	Alinagar, Benares	690	6·53	2·66	·45	9·64	1·02	
43	Fatehpur	697	6·18	2·90	·92	10·00	1·00	
44	Bidakhar, Hamirpur	703	16·22	3·97	·41	20·60	2·51	

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45	Chaki, Jalaun	707	4·42	1·36	·20	5·98	·73	Ordinary samples of nitrous earths obtained from various districts. The first three samples represent good, middling, and inferior samples collected when season had fairly begun; the remainder collected in the same place at intervals during manufacturing season.
46	Mahgaon, Allahabad . .	709	3·42	1·85	1·29	6·56	·54	
47	Andakila, Saran . . .	747	1·69	1·30	·48	3·47	·29	
48	Lalganj, „ . . .	748	1·25	·69	1·56	3·50	·21	
49	Jahanabad, „ . . .	779	1·06	·26	1·45	2·77	·17	
50	Muzaffarpur	758	2·59	·98	1·43	5·00	·44	
51	Barhanpura, Muzaffarpur .	759	3·02	1·68	1·62	6·32	·49	
52	Dokra, „ . .	760	·92	·60	1·23	2·75	·17	
53	Gujrat, Panjab . .	820	3·28	1·43	·65	5·36	·51	
54	Siripur, Saran, good . .	542	1·13	·70	·88	2·21	·18	
55	„ „ middling . .	543	1·21	·85	1·23	3·29	·19	
56	„ „ inferior . .	544	4·97	2·61	7·32	14·90	·90	
57	„ „ 1st February .	552	2·50	1·17	1·85	5·52	·41	
58	„ „ 15th „ .	553	1·96	1·29	1·07	4·32	·29	
59	„ „ 1st March . .	554	2·22	1·58	1·68	5·48	·37	
60	„ „ 10th „ . .	556	1·11	1·16	·78	3·04	·15	
61	„ „ 1st April . .	557	2·96	1·68	2·08	5·72	·48	
62	„ „ 16th „ . .	557	2·11	1·45	1·52	5·08	·37	
63	„ „ 1st May . .	558	2·21	1·45	1·46	5·12	·36	
64	Dindialpur, refinery earth (closed shed).	654	4·80	4·14	·88	9·82	·72	
65	Dindialpur, refinery earth (soil from exposed yard).	655	8·85	6·43	3·68	18·96	1·44	Refinery earth collected in open yards and in closed sheds.
66	Barhanpura refinery earth (from yard).	761	5·32	3·35	6·88	15·73	·93	
67	Barhanpura refinery earth (from inside shed).	763	1·97	1·47	2·04	5·48	·32	
68	Kheora (1st Factory) earth .	389	3·06	2·84	2·86	8·76	·48	Ordinary samples of factory site earth.
69	„ (2nd „) „ .	395	13·47	8·03	3·32	24·82	2·06	
70	Hansi (Factory soil) . .	436	5·30	4·14	3·72	13·16	·71	
71	Shahzadpur, Allahabad (refinery).	710	4·26	2·49	2·75	9·50	·74	
72	Parsanni refinery earth . .	762	1·63	1·24	2·31	5·18	·27	

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Manufacture of crude saltpetre.

The Manufacture of Crude Saltpetre.

The preparation of crude saltpetre from nitrous earth consists of two distinct but simple processes. The first is the leaching or exhaustion of the saline matter by allowing water to percolate through the nitrous earth. The second is the evaporation of the liquor so obtained either by the agency of the sun's rays or by the employment of artificial heat. These processes are conducted in some districts of Bengal by a special caste of men called *Luniahs* or *Nuniahs*, but in parts of the United Provinces and the Panjab ordinary villagers of no special caste engage in the industry. In the neighbourhood of Hissar the crude nitre-makers are generally low caste *kumbhars* (potters) or other Hindus or Musalmans. They are occasionally called *shoragars* or nunaris.

Collecting the earth.

The season for collecting the nitrous earth lasts from November to the commencement of the monsoon. The surface of the soil is scraped off to a depth of half to one inch by means of the ordinary country spades (*kodali*). Some *Nuniahs* scrape the earth with broken tiles or pieces of earthen pot. The earth thus collected is made into heaps, or is taken direct to the factory in head-loads, or donkey-loads. Patches are scraped and the earth collected until the leased area is gone over. The process is repeated throughout the fine season at intervals which may range from 4 or 5 days to as much as a fortnight.

In a factory examined at Murwanpur, 4 miles from Cawnpore, the following arrangements were found. One boiling pan was at work, and the fuel consisted of dried leaves and stalks brought in head-loads by the wives of the workers. Six men were at work, and the nitrous earth was obtained from the walls of the village huts and compounds.

Leaching the earth.

The earth is stacked by the side of two oblong pits or filters (*kuria* or *kothi*) 7 feet long, 3 feet broad and 1 foot deep. They are placed end to end with an earthen *ghara* or jar (*nand*), 1½ feet in diameter, buried in the ground between them. The floor of the filter is made of puddled clay and is so arranged that the slope on either side is towards the central longitudinal line of the filter. This central line has a slope towards the outlet connecting with the jar. On the floor is laid a framework of small brushwood the sides of which rest on the clay and the cross-pieces of which are laid on top of the side-pieces. The filter is carefully packed with the nitrous earth, and water is then poured on the surface, which commences to trickle out in one hour or so as nitrous brine. After the first charge of water, more is poured on the surface until the brine trickling out appears to be too weak to work. The exhausted soil from the filters is then

taken out and thrown on a heap which gets large by the time the season ends. The liquid from the *nand* is baled out and transferred to an iron evaporating pan or boiler (*karahi*) which is supported on a brick fire-place. The boiler is 5 feet in diameter and is made up of iron sheets riveted together, and costs about R20. The liquor is boiled for about 7 hours or until it is sufficiently concentrated. To determine this a drop of the solution is taken and placed on the thumb nail. If crystals appear at once, the boiling is considered to be complete. Crude saltpetre.

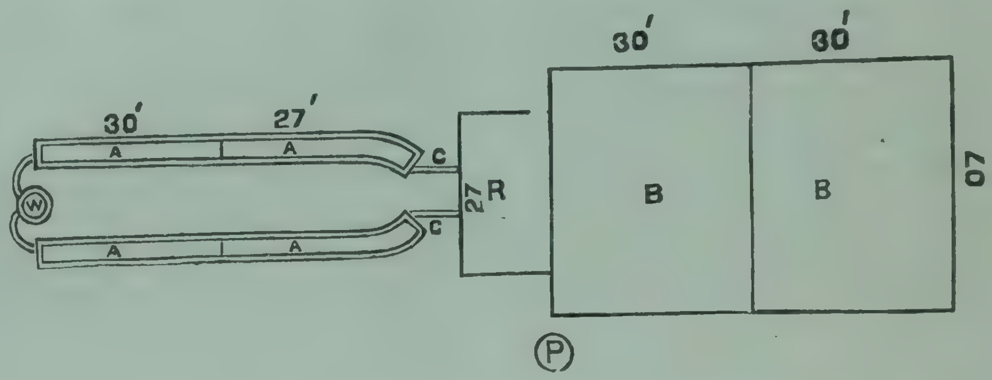
The hot boiled liquid is transferred to open vessels of rough pottery to cool and crystallise. The crystals will usually have sufficiently formed to be collected next morning. They are taken out and drained in baskets which act as filters, and then thrown into a pit in the ground where the crude saltpetre, or *kachcha shora*, as it is locally called, is stored. Crystallising.

The *Nuniahs* are careful not to lose any of the nitrates. The mother-liquor from each boiling is added to the fresh brine obtained from the filters, and the mixture is treated as above described. The mother-liquor after several boilings, becomes greatly saturated with salt. It is then thrown on the heap of exhausted earth which, after exposure to the air, again yields nitrous earth. The outturn of crude saltpetre from this factory came to about 78 maunds in the season, and was sold to a refinery at Cawnpore at R3 per maund of $82\frac{2}{7}$ lbs. Residues preserved.

In Behar smaller boilers and sometimes earthen pots are used and the filters are round instead of oblong.

The method of making crude saltpetre by the heat of the sun is practised in the drier parts of the Panjab and in other provinces where the climate permits. The crystallising beds or pans used in this process are termed *pata*, and the resulting saltpetre or *abi shora* as it is called is not considered to be of such a good quality as *jaria shora* or crude saltpetre prepared by artificial heat. Evaporation by solar heat.

A large quantity of *abi shora* is made annually at Hansi in the Hissar district, where personal enquiry into the industry during the hot weather of 1902 has made it possible to give a short description of the manufacture. The soil is collected at Hansi castle, an old ruin, the walls and moat of which supply nitrous earth, and the sum of R300 per annum is paid to Government for the privilege of collecting it. It is conveyed in donkey-loads to the factory which is situated by the side of a main road outside the town. The arrangement of the beds for leaching the nitrous earth and evaporating the nitre liquor is shown in the accompanying sketch :— Description of process.



Crude saltpetre.

A A Beds or filters (*kurias*) for the filtration of the nitrous earth.

B B Beds (*patas* or *kiaris*) for evaporating the nitre liquor.

C C Channels to conduct the liquor to the evaporating beds.

R *Jhela* or reservoir.

P Pit for storing the saltpetre.

W Well for supplying water.

The *kurias* are 25 to 30 feet long, 6 feet broad, and 1 foot deep. There are two of these *kurias* which are sometimes sub-divided and arranged in two rows, running parallel, and situated on a broad hillock raised 3 or 4 feet above the ground. The beds are made of plastered clay or lime and are practically water-tight. The two evaporating beds are built on the level ground, and have concrete floors and sides. These are about 6 inches deep and 25 to 40 feet square. They communicate with one another, and the smaller bed, which is raised slightly above the larger ones and is nearer the mound, serves as a reservoir for collecting any nitre water that is not required by the other beds.

Evaporation by solar heat.

The salt earth is carried to the *kurias* and is packed in them to a height of about 8 inches. It is sometimes mixed with ashes in order that the soil may remain open and porous when the water is added, and possibly also with the object of decomposing the calcium and magnesium nitrate with the carbonated alkali. When the packing of the earth is complete, then water from the well (W) is baled up by earthen pots and poured over the nitrous soil and is allowed to filter slowly through it in order to dissolve the saline matter. The saturated liquor flows off in a small stream, through the concrete channel, into the large shallow evaporating beds. Meantime the other bed is filled as described with earth and water, and filtration and drainage go on regularly in rotation in the filters until enough liquor is obtained to fill the lower evaporating beds. The exhausted earth is removed from the *kurias* when the water extract has been fully drained off.

Crude saltpetre.

As the yellowish liquid in the evaporating beds becomes more concentrated the nitre begins to crystallise at the sides and bottom, and after about seven days most of the nitre has solidified and it is raked together into parallel ridges along the length of the bed about 3 feet apart. The mounds of crude crystals, after further drying, are collected together into heaps and then carried in baskets to a pit made in the ground a short distance off. The evaporating *kurias* are never allowed to become quite dry during the working season, in order to avoid cracking ; as soon as the damp crystals are removed to the pits fresh nitre liquor is run in from the reservoir, and evaporation is continued. Each *kuria* is said to yield 20 to 30 maunds of crude nitre per week. The nitre prepared in this manner is placed in the storage pit until it is sold.

Composition of crude Saltpetre.

Composition of crude saltpetre.

The quality of crude saltpetre of commerce is considerably influenced by the quality of the nitrous earth from which it is made and the processes adopted for its manufacture. When artificial heat is employed for evaporation, impurities are removed by skimming and are also precipitated when the concentrated brine is allowed to settle before it is run into the crystallizing pans or vessels. Therefore the crude nitre is ordinarily purer than that produced by solar evaporation where nearly everything that is crystalline is collected. In the tabulated Statement No. II the analyses of 55 samples of crude saltpetre are given. The analyses are arranged in four groups, and the headings indicate the reasons for grouping. The amount of potassium nitrate ranges from nearly 80 per cent. in a sample (702) from Hamirpur to 26·8 per cent. in an inferior sample from Okara, the average percentage of 53 predominating. The chief impurity in crude saltpetre is common salt. In India this impurity has no commercial value as manure. A few samples from Bihar show a rather large percentage of sodium sulphate, and several of the inferior samples in the list contain excessive quantities of insoluble substances. The sample 730 from Bhawani appears to be adulterated with *khari* salt or crude sodium sulphate.

Impurities.

A practised eye can determine with fair precision the amount of nitre in a particular sample from the proportion of small elongated prisms peculiar to the alkaline nitrate as distinct from the granular or cubical crystals of the common salt. A refiner in Cawnpore during my visit was purchasing crude nitre from Rampur State and declared the sample to be superior and worth R3-8 a maund. The sample No. 384 was analysed and yielded 67·73 of potassium nitrate. The expert dealer was therefore right in his judgment. But

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Composition of crude saltpetre

the prices quoted in the list of analyses do not indicate that they vary with quality in the way they ought to do. An uneducated, inexperienced cultivator would certainly be handicapped in buying supplies as manure, and without actual analysis it is difficult to suggest any practical form of protection. It is clear from the prices quoted by the officers of the Salt Department that the manufacturer of crude nitre would often be a gainer if a definite standard valuation was introduced. The same standard of valuation would not be suitable for very inferior and very superior samples, because a high percentage of common salt or other impurity would add to the cost of refining or add to the cost of transport. Ordinary samples of crude nitre apparently have from 40 to 64 per cent. nitrate of potash, and samples of this class would, at present market rates, be worth at manufactories within easy distance of railways in the north of India, one anna per unit per maund for the percentage of potassium nitrate present. A sample containing 40 per cent. nitrate of potash would thus be worth 2-8 per maund, and samples containing 64 per cent. of nitre, R4 per maund. Samples containing under 40 per cent. nitre should be valued at less, and samples containing over 64 per cent. nitre at more, than one anna per unit. Crude saltpetre is cheapest just before the rains, being inferior owing to the conditions of temperature under which it is made. At this time refiners often buy extensively because crude saltpetre cannot be made during the rainy season.

Valuation.

It may be stated that crude nitre of high quality can be produced easily and cheaply from rich nitrous earth, but the nitrous soil of villages is the property of landholders and is rented out to saltpetre manufacturers. Rents vary with productiveness of soil. Matters are therefore equalized to some extent in this way. It has yet, however, to be determined whether crude nitre of high quality can be produced *economically* at existing market rates from the poorer qualities of nitrous earth. This is a matter for further enquiry.

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STATEMENT II.—*Analyses of samples of crude saltpetre.*

Serial No.	Source of Sample.	Register No. of the sample in the office of the Agricultural Chemist.	Moisture.	Nitrate Potassium.	Chloride Sodium.	Sulphate Sodium.	Nitrate Calcium.	Nitrate Magnesium.	Insoluble.	Nitrogen.	Value at one anna per unit of Potassium Nitrate.	REMARKS.
1	2	3	4	5	6	7	8	9	10	11	12	13
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	R a.	
1	Shahawar, Etah, good quality	429	6.40	44.57	28.40	6.08	2.95	9.60	2.00	8.47	2 12	
2	" " middling	430	2.90	51.61	28.96	11.56	1.14	2.93	.90	7.86	3 0	
3	" " inferior	431	4.80	28.21	39.19	15.22	1.65	9.73	1.20	6.01	1 12	
4	Muttra, good	454	7.10	46.06	25.87	5.62	4.42	8.13	2.80	8.63	3 0	
5	" middling	455	4.70	39.52	37.63	3.40	4.92	2.93	6.90	6.83	2 8	
6	" inferior	456	7.80	50.57	27.04	3.06	4.10	6.13	1.30	8.82	3 0	
7	Hardoi, quality I, R4	868	6.90	64.22	19.14	2.16	2.62	3.56	1.40	9.97	4 0	
8	" " II, R3	869	5.30	55.58	27.84	3.84	2.62	2.93	1.80	8.64	3 8	
9	" " III, R2	870	7.00	44.58	6.96	17.20	4.56	3.20	16.50	7.52	2 12	
10	Farukhabad, quality I, R3-2	671	5.00	66.07	21.84	3.65	...	2.54	.90	9.58	4 0	
11	" " II, R3-2	873	4.30	65.84	22.04	4.36	1.96	...	1.50	9.41	4 0	
12	" " III, R1-13	874	3.70	44.92	35.38	10.00	...	4.80	1.20	7.10	2 12	
13	Gurwa, Ghazipur, superior, R3	674	8.90	47.32	28.56	3.16	4.56	6.40	1.10	8.48	3 0	
14	" " inferior, R2-8—R2	675	6.80	30.38	17.92	3.16	6.14	4.80	20.80	6.14	1 14	
15	Okara, Montgomery, Panjab, good	718	5.20	53.00	34.22	3.88	2.60	...	1.10	7.75	3 8	
16	" " " middling	719	6.50	43.98	44.66	2.92	tr.	1.04	.90	6.25	2 12	Described as good, middling and inferior, or 1st, 2nd, and 3rd quality.
17	" " " inferior	720	13.50	26.86	34.80	11.20	...	12.24	1.40	6.02	1 10	
18	Bhawani, Montgomery, Panjab, good	728	3.60	54.60	26.68	9.56	4.56	tr.	1.00	8.30	3 8	
19	" " " middling	729	5.30	41.78	35.38	9.24	1.96	2.64	3.70	6.59	2 8	
20	" " " inferior	730	7.90	33.96	19.72	30.92	1.28	4.12	2.10	5.67	2 0	
21	Hansi, Hissar, good	438	2.60	51.58	33.51	1.34	3.44	5.33	2.20	8.81	3 0	
22	" " middling	440	3.10	41.56	35.78	3.36	4.84	9.06	2.30	8.85	2 8	
23	Sirsa, Hissar, good	736	3.30	57.50	27.84	4.13	3.93	tr.	3.30	8.59	3 8	
24	" " middling	737	3.60	51.83	31.94	8.21	2.62	...	1.80	7.59	3 0	
25	" " inferior	738	7.10	43.49	27.26	8.22	4.59	4.24	5.10	7.58	2 12	
26	Shahpur, Panjab, good	743	9.30	39.22	31.90	5.60	5.24	2.64	6.10	6.71	2 8	
27	" " middling	744	8.00	44.81	28.42	5.08	5.25	4.24	4.20	7.87	2 12	
28	" " inferior	745	8.00	45.08	30.78	6.32	3.04	3.72	3.10	7.43	3 0	

STATEMENT II.—*Analyses of samples of crude saltpetre*—continued.

Serial No.	Source of Sample.	Register No. of the sample in the office of the Agricultural Chemist.	Moisture.	Nitrate Potassium.	Chloride Sodium.	Sulphate Sodium.	Nitrate Calcium.	Nitrate Magnesium.	Insoluble.	Nitrogen.	Value at one anna per unit of Potassium Nitrate.	REMARKS.
1	2	3	4	5	6	7	8	9	10	11	12	13
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	R a.	
29	Andakilar, Saran, R2-8	751	9·30	42·40	37·70	3·40	1·28	5·32	·60	7·07	2 8	Valued at certain rates per maund of 82⅔ lbs.
30	Jahanabad, Saran, R2-12	752	6·10	57·42	26·68	9·20	...	...	·60	7·92	3 8	
31	Lalganj, Saran, R3	753	7·50	48·42	39·44	4·64	...	tr.	4·64	6·68	3 0	
32	Muzaffarpur, Saran, R2	767	7·00	49·36	16·82	14·60	3·28	7·44	1·50	8·77	3 0	
33	Mahgaon, Allahabad, R2-8	713	9·10	59·72	22·04	2·16	1·28	4·80	·90	9·36	3 8	
34	Shahzadpur, Allahabad, R2-8	714	5·80	65·56	25·52	...	...	3·12	...	9·64	4 0	
35	Allahabad (solar process, filters)	712	15·20	35·02	30·70	5·84	tr.	12·24	...	7·15	2 0	Manufactured by means of solar heat.
36	Hamirpur (solar process) R2-8	702	5·20	79·70	5·80	2·16	5·24	tr.	1·90	11·88	5 0	
37	Chak, Jalaun (solar process) R2-8	708	7·10	55·80	26·10	2·68	4·56	1·76	2·00	8·80	3 8	
38	Dumraon Farm	269	5·06	53·74	34·08	2·96	2·29	tr.	1·87	7·79	3 8	Ordinary commercial samples used as manure by Government farms and also obtained direct from manufacturers.
39	Dumraon Farm	863	7·30	55·30	33·06	1·68	1·96	...	·70	7·96	3 8	
40	Burdwan "	321	6·92	53·51	28·08	2·43	4·92	...	4·14	8·20	3 8	
41	Rampur State	384	2·40	67·73	19·31	4·02	1·31	4·13	1·10	10·34	4 0	
42	Siripur	545	4·90	33·73	22·34	10·73	5·90	4·80	9·60	6·51	2 0	
43	Siripur	651	12·70	40·36	14·70	2·68	12·26	5·60	11·70	8·70	2 8	
44	Siripur	849	9·40	37·16	11·02	18·42	7·84	1·76	14·40	6·78	2 4	
45	Siripur	879	10·40	46·46	8·12	15·60	7·20	2·12	10·10	8·03	3 0	
46	Siripur	880	11·80	45·08	6·38	14·60	7·84	1·60	12·70	7·85	2 12	
47	Marh, Saran	659	4·40	58·20	22·34	3·90	3·92	2·64	4·60	9·19	3 8	
48	Hakwa, Saran	662	6·20	54·00	25·20	2·92	5·24	2·64	3·80	8·10	3 8	
49	Dokra, Bihar	765	7·20	62·60	23·78	2·40	1·28	2·64	·10	9·34	4 0	
50	Barhanpura, Saran	766	3·80	68·40	17·98	3·40	2·60	2·12	·70	10·27	4 4	
51	Kheora, Cawnpore	390	3·80	47·67	28·96	8·64	1·80	7·33	1·80	8·26	3 0	
52	Malon, Kheora, Cawnpore	396	2·10	75·39	17·60	1·08	·80	2·53	·50	11·01	4 12	
53	Alinagar, Benares	693	5·10	76·47	11·76	3·16	1·31	1·60	·60	11·07	4 12	
54	Fatehpur, Allahabad	696	9·20	73·79	6·16	2·43	2·60	5·32	·50	11·63	4 8	
55	Gujrat, Panjab	819	5·00	63·20	26·32	2·43	1·31	1·04	·70	9·07	4 0	

The Refining of Saltpetre.

The refining of saltpetre.

A saltpetre refinery consists of a large fenced yard with office and godowns and sheds for the factory occupying sometimes several acres of land. One portion of the yard is covered with earth suitable for crude nitre production. When a refinery is first established nitre earth is obtained and spread on a part of the yard. The salt from the nitrous earth obtained from this area is extracted in the ordinary way with water, and the exhausted earth is spread out on this portion of the yard to receive the furnace ashes and nitrous by-products from time to time. The ashes, soil, and washings are mixed intimately, and fresh nitre is constantly generated from the "factory soil." It is a common opinion that such earth is better than new earth collected from outside. At any rate it is a continual source of crude nitre to the refiner, and it enables him to use to the best advantage all the products of his factory which otherwise might be wasted.

Description of refinery.

The accompanying is a sketch of a refinery at Jajmow, Cawnpore, in the United Provinces. The yard is enclosed with a high mud wall and gate. One portion of the yard (M) is covered as described above with *lunamatti* or nitre earth. At the left corner there are two pairs of filters or *kurias* (KK) for extracting crude nitre from nitrous earth. A well (W) supplies the water for this process as well as for making solutions for the refining process. There are four iron evaporating pans (PPPP) supported on masonry fire-places. Here the nitre liquor is boiled. Near each pan is another empty pan or wooden vessel to serve as a settling tank. From this the liquid is transferred to the crystallising tubs (C) arranged under the sheds. These tubs are so arranged that each day as two or more are filled, two or more are emptied, and the crystals collected. The round tubs are for making crude nitre or small refined crystals; the larger oblong vessels are for the production of the higher quality or *kalami* saltpetre. One of the most important utensils in the refinery is a boiler or iron pan for evaporating the liquor. The pan is from 10 to 12 feet in diameter, and costs R260; if well made, one will last ten years. It is supported on a brick-and-chunam furnace, which is 25 feet long, 15 feet broad, and 4 feet deep. Two sloping slides enable men to carry the crude nitre to the pan. In the front is the door of the furnace. At the other end nearest the sheds is a cistern of solid masonry or a spare pan. Under the sheds are arranged the crystallising vessels, which are wooden oblong tanks 7 feet long, $5\frac{1}{2}$ feet broad, and 2 feet deep, where the nitre crystals form.

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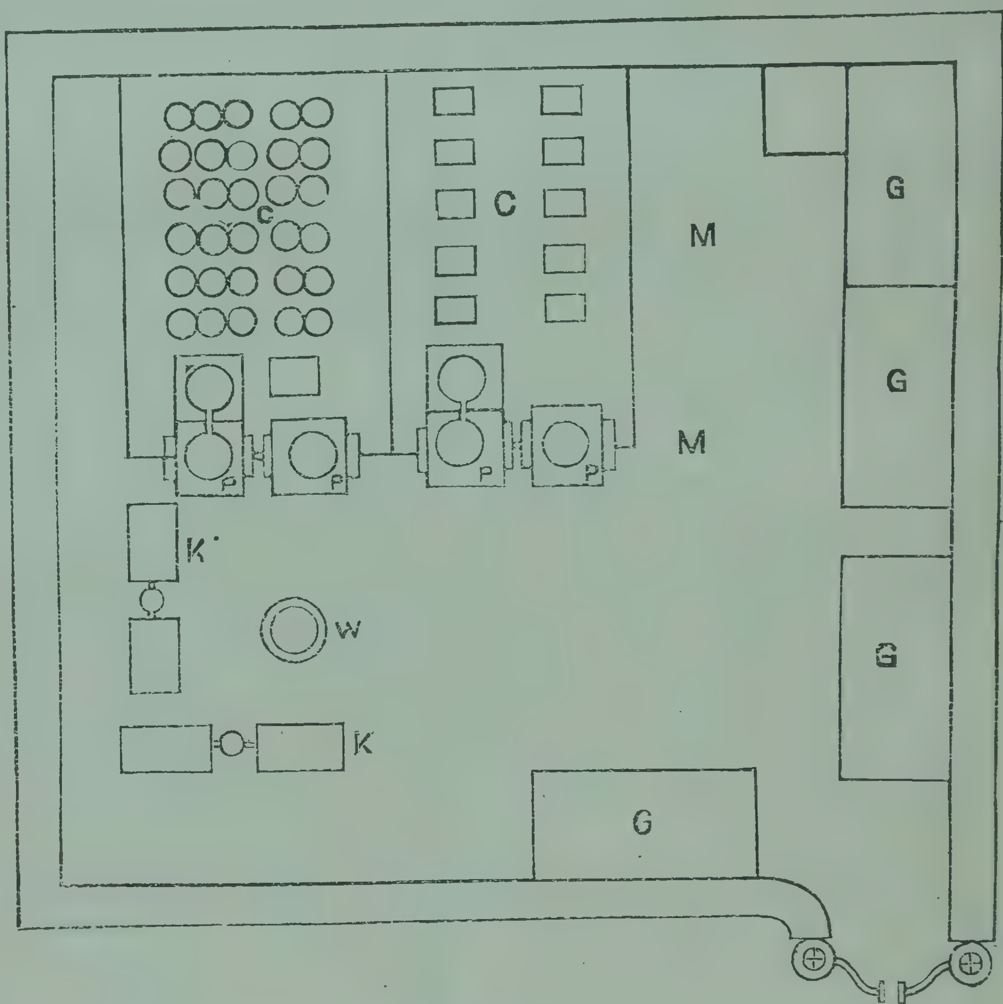
Refining of saltpetre.

The process followed varies in different refineries and in different parts of the country. But as the chloride of sodium is the principal impurity and as its solubility is practically constant, all the processes followed are based on the varying solubility of nitrate of potassium in hot and cold solutions.



To start a refinery, the nitre earth obtained from the factory soil is filtered in the two pairs of *kurias*. The crude nitre solution obtained from these is boiled down, clarified by sedimentation and set out to crystallize. In from six to ten days the crystals are extracted and the residual *tor* or mother-liquor is then available for future use. Crude saltpetre is dissolved in this mother-liquor to which sufficient water or washings are added to keep up the volume. The main supply of crude nitre is obtained by purchase from small manufacturers. A well near the centre of the yard supplies sufficient water,

Refining of saltpetre.

usually of a saline character for the operations. When crude nitre is dissolved in *tor* or mother-liquor and the solution is concentrated by boiling in the large evaporating pans, a dirty white granular substance known as *sitta* falls to the bottom of the pan. The *sitta* as it forms is removed by means of a large iron spade fixed to a handle 6 feet long. The *sitta* thus obtained is sometimes washed and the washings are returned to the pan. In Behar, where *sitta* is not excised, it is mixed with the refinery earth. About 2½ maunds of *sitta* is separated from each pan of liquor. At a factory near Cawnpore the proportion of *sitta* was said to be 20 per cent. of the crude saltpetre.

Sitta.

Scum.

The evaporation of the liquid in the pan is continued at the temperature of boiling water. In some factories the froth or scum, called *zag*, *zoga*, *mail* or *phain*, is removed from the surface at this stage, in others it is removed after transfer to the settling tank. After boiling for three hours, or until the liquid changes from a dark to a light yellow colour, the concentration is considered complete. The liquid is emptied out of the pan by means of an iron scoop known as a *dal* hung at four corners by ropes. Two men stand on opposite sides each holding two ropes. They deftly raise the liquid in the *dal* from the pan and pour it into the wooden trough which leads it to the settling tank. Here the hot liquid is allowed to settle for about 2 hours. The scum or *zag* is taken off with an iron perforated *jhara*, and the clarified liquor is decanted, or syphoned off with a bent brass tube, into one or more crystallising vats. At the bottom of the settling tanks is found a substance called *matiaree,* which is a by-product containing nitrates, and is accordingly carried off and mixed with the nitrous earth in the factory yard. The crystallising vats under the sheds are filled with nitre liquor to about 6 inches from the top. In the United Provinces on the surface of each is floated a trellis work made of interlaced bamboo sticks (called *tattis* in Cawnpore). This device facilitates the formation of good crystals. After seven days the bamboo frames are removed and the adhering nitre crystals are shaken or picked off, and the crystals at the bottom and sides of the trough collected into a heap and drained. At Kheora, Cawnpore, troughs of two sizes are used. There are some 3 by 5 feet, which require the liquor to remain eight days, and others, 6 feet square, where the liquor remained ten days. The larger the vessels and the longer the liquor stands, the larger and longer are said to be the crystals.

Crystallising.

The damp saltpetre is contaminated with the mother-liquor adhering to it, and minute crystals of salt, and these must be removed by washing before the salt is ready for the market. Plain water is

Refining of saltpetre.

used for this purpose. Alum is occasionally used for the same purpose as indigo blue to whiten the saltpetre. Alum is also used in admixture with saturated nitrous liquor before it is run into the crystallising vats, in order to precipitate matter in suspension in the liquid. Bags containing the refined substance are placed over an empty tub or vat which is slightly tilted to allow the liquor to drain. Cold water is sprinkled from time to time upon the saltpetre through the open mouth of each bag. This water trickles slowly through the saltpetre crystals carrying with it inferior salts in solution. Some saltpetre is also dissolved but the loss is not great. After the washing the refined saltpetre is spread out and dried, and after remaining a few hours is conveyed to the store godown.

Tor.

The mother-liquor or *tor* from the crystallising vats and all washings of the refined saltpetre, and of the settling and setting vats and of *sitta* are returned to the evaporating pans and used for dissolving fresh crude nitre. It is thus seen that the utmost economy is practised at every stage of the refining processes, and, practically speaking, no nitrate is wasted.

One evaporating pan is capable of dealing with two boilings (40 maunds of crude nitre) per day. The boiling begins early in the morning and is finished by midday. It is calculated that one maund of crude nitre according to its quality will yield from 15 to 23 seers (37·5 to 57·5 per cent.) of refined nitre.

Fuel.

The fuel used at Hansi is cotton stalks, and costs R1 per day. At other factories other cheap fuel, such as dried castor stalks and wild shrubs, is used.

The total output from the refinery described is 2,800 to 3,000 maunds in a season, but the output from any refinery will vary with the quality of the crude nitre. The list of analyses indicates that the quality is very variable.

Government regulations.

A Government license costing R50 is required. The owner is required to keep regular records of all production and purchases of crude saltpetre, the quantity of refined saltpetre produced, and of the *sitta* and salt, and details of issues. He is also required to submit weekly returns to the Assistant Commissioner of Northern India Salt Revenue. Officers of the Salt Department visit these refineries whenever they wish in order to check the records, inspect the premises, and see to the removal under the rules and on payment of duty of any salt or *sitta* the owner may desire to excise for sale or to the destruction of any salt or *sitta* the owner may apply to have destroyed. *Sitta* contains a large proportion of common salt, and if removed for sale the nitre refiner is compelled to pay a tax of R1 a maund.

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STATEMENT III.—*Analyses of refined saltpetre.*

Serial No.	Source of Sample.	Register No. of sample in the office of the Agricultural Chemist to the Government of India.	Water.	Potassium Nitrate.	Sodium Chloride.	Sodium Sulphate.	Calcium Nitrate.	Nitrogen in Nitrates.	REMARKS.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1	Jajmou, Cawnpore, *kalami*	388	1·50	97·37	1·13	...	tr.	13·44	
2	" " unwashed	385	3·23	92·83	3·97	...	tr.	12·69	Ordinary samples of refined saltpetre.
3	Kheora (1), Cawnpore	393	·30	91·34	7·52	·84	tr.	12·60	
4	" (2), "	399	·10	93·74	5·68	·48	tr.	12·93	
5	Hissar, Hansi, Panjab	437	·70	94·92	3·40	·48	tr.	13·09	
6	Siripur, Saran, No. 1	548	1·60	90·16	7·64	·60	tr.	12·44	
7	Dindialpur, Saran, refined	657	3·90	82·68	10·58	1·68	·66	11·52	
8	Sewan, Saran, *kuthia*, refined	931	4·60	89·80	4·64	·96	...	12·37	
9	Bans Deeh, *kuthia*	688	4·20	90·16	3·92	tr.	1·72	12·73	
10	Okara, Montgomery, Panjab	723	3·70	92·68	2·90	·72	...	12·78	
11	Barhanpura, Bihar, refined	770	5·30	90·64	4·06	...	...	12·50	
12	" " washed	771	4·10	94·16	1·74	...	...	12·99	
13	Shahzadpur, Allahabad, R6	711	4·80	93·46	1·74	...	...	12·89	Samples of ordinary refined saltpetre and *kuthia* saltpetre, with market rates for each sample.
14	Bidakhar, Hamirpur, R5	704	2·60	89·86	7·54	...	...	12·40	
15	Lalganj, Saran, R5-8	754	3·10	92·00	1·74	3·16	...	12·69	
16	" " *kuthia*, R4	755	4·30	74·42	16·24	2·40	2·64	11·76	
17	Barhanpura, Bihar, *kuthia*, R4	768	4·70	74·96	19·14	1·20	...	10·34	
18	Dindialpur, Saran, *kuthia*	656	2·80	74·08	19·40	1·96	1·74	10·55	*Kuthia* saltpetre.
19	Sewan, Saran, *kuthia*	930	3·80	75·90	18·56	1·68	...	10·47	
20	" " washed, *kuthia*	932	2·10	91·02	5·22	·96	...	12·56	
21	Gorakhpur, *kuthia*	687	4·70	85·50	7·84	tr.	1·96	12·12	
22	Cawnpore Farm	350	7·70	83·09	8·42	·79	...	10·51	Samples used as manure at the Cawnpore and Nagpur Farms.
23	" "	908	2·60	77·24	18·56	tr.	1·60	10·95	
24	Nagpur Farm, R4-8	441	·10	84·25	11·36	·85	·82	11·75	
25	Siripur, Saran, No. 2	549	1·60	65·22	32·34	·84	tr.	9·00	Adulterated sample.

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Composition of refined saltpetre.

The Composition of Refined Saltpetre.

In Statement III the analyses of twenty-five samples of refined saltpetre are arranged in five groups. The reason for grouping is indicated by the headings. Refined saltpetre is called by the manufacturers *kalami shora,* and the analysis shows that the native refiner in this country with his ordinary arrangements can turn out refined saltpetre practically pure. The first sample on the list was perhaps extra carefully refined. The second analysis is of crystals from the same batch which were dried without washing.

The impurities present in refined saltpetre are chlorides and sulphates of potassium and sodium, moisture and insoluble substances.

The first twelve analyses on the list show that samples which are refined in a reliable way are generally of fairly high standard of quality.

The market rates are given for the next five samples on the list, and these indicate that the relation between quality and actual value is fairly recognised in the case of refined saltpetre.

Kuthia saltpetre.

The two last samples of this group and the four samples of the next group are called by refiners *kuthia* saltpetre. The term is derived from filters which in Bihar are called *kotis.* This is a white salt which crystallises with a large proportion of chlorides varying in the samples from 7·8 to 19·14 per cent. It is made by evaporating nitrous brine obtained from filtering the refinery earth. *Tor* or mother-liquor is sometimes added.

The samples of the next group were used as manure at the Cawnpore and Nagpur Farms. They are more akin to very good samples of crude nitre than to refined nitre. The Nagpur sample costs R4-8 per maund at Cawnpore and R6 per maund landed at Nagpur, and is not dear at the price. The last sample on the list has obviously been adulterated. It should be noticed that the samples used as manure this year at the Dumraon, Siripur, and Burdwan Farms were distinctly crude and very dear, which proves that buying in the bazar is more or less a lottery.

Saltpetre for gunpowder.

When required for the manufacture of gunpowder saltpetre must possess a high degree of purity. At the Ishapur Factory where until within the last two years gunpowder has been made for Indian consumption, saltpetre "grough" is purchased from Bihar and further refined at the powder factory until a crystal of saltpetre will dissolve in a solution of silver nitrate without producing a cloudiness. A sample of the "grough" bought by the Superintendent, afforded the following analysis:—Insoluble ·08, water 1·97, sodium chloride ·69,

Composition of refined saltpetre.

sulphate potassium ·04, or a refraction of 2·78 per cent., leaving 97·22 per cent. of potassium nitrate.

9th July 1902.

An advertisement recently appearing in the *Government of India Gazette*, for a tender of 10,000 cwts. of saltpetre for use in the cordite factory at Wellington, specified the following limitation of impurities:—"It must contain not less than 95 per cent. potassium nitrate and not more than 0·85 per cent. of chlorides, calculated as sodium chloride determined by analysis of the dried saltpetre."

Having now shown the nature of the impurities naturally associated with saltpetre, and after discussing the method of their removal, it only remains to give the ultimate composition. The chemical formula of saltpetre is KNO_3, and in the absolutely pure salt the elements are combined in the following proportion:—

Potassium 38·62, Nitrogen 13·86, Oxygen 47·52 = 100·00

The price of refined nitre was last season R5-8 to R6 per maund in Bihar and Hissar, and R8 in Cawnpore, and that of extra good quality with large crystals R9 at Cawnpore.

Sitta and Common Salt.

Sitta.

The Inspector General of Agriculture caused particulars to be collected regarding the use and trade in the common salt educed in the saltpetre refineries. Sodium chloride is a constant ingredient in nitrous earth, and constitutes the chief impurity of crude saltpetre. During the concentration of the nitrous liquor by boiling, it is thrown out of solution in considerable quantity and is afterwards easily divested of its impurities. The cause of this deposition is owing to the difference in the solubility of the two salts with the rise of temperature. A quantity of nitrous mother-liquor, saturated in its cold state with saltpetre and chloride of sodium, is placed in a boiler and heated to the boiling point, a little water having been added to it to maintain it in full quantity while being heated. Crude saltpetre is then thrown into it, the nitrate of potassium is taken up in the liquid in solution, and the chloride of sodium with other impurities remains undissolved at the bottom of the boiler and is removed. This undissolved matter is true *sitta*. It is composed for the greater part of common salt mixed with other salts, earth and nitrogenous matter. A similar substance is produced when crude saltpetre is dissolved in mother-liquor diluted by the mixture of nitrous brine from the refinery filters. In such case the chloride of sodium is all dissolved, but is again precipitated when the solution is concentrated to the saturation point of saltpetre. Removed in admixture with earthy and other impurities this impure salt is very

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Sitta.

like true *sitta* and is classed as such, impure and inedible saltpetre salt.

In the tabulated analyses of fourteen samples of *sitta* from the Panjab, United Provinces, and Bengal, the percentage of alkaline chlorides varies between 26·68 and 72·5. The sample (No. 486) from Hansi, Hissar, was collected from the drain in the factory where it had been destroyed by mixing with earth and water. The saline matter was recovered in the laboratory at Dehra Dun and afterwards analysed. The separated salt contained 85·2 per cent. of pure sodium chloride with small amounts of sulphates and nitrates.

A tax of R1 a maund is paid for excising *sitta* from refineries in the Panjab, and in the Agra and Farukhabad circles of the United Provinces. The fee was raised from 8 annas to R1-0-0 with effect from 1st July 1901, as there was some reason for supposing that the concession was being abused. In Hansi it is said the selling price is so little above the tax paid for it that it is not worth keeping for sale, hence it is destroyed. In other places *sitta* is occasionally sold for preserving hides and dressing leather. It is also used for preserving coarse beef intended for export to Burma. But in most factories where impure salt is separated it is never sold to the public but is converted into alimentary salt.

Uses of sitta.

Edible salt.

To educe edible salt crude saltpetre is thrown into a liquid sufficiently poor in saline matter to take up all of the salts in solution. When the concentration of the liquid approaches the precipitation point of salt, it is removed to a settling vat and impurities in suspension are allowed to subside. It is finally put back into the boiler and further concentrated until salt precipitates and can be removed. The purification of *sitta* (impure salt) is generally effected by dissolving it in nitrous brine. The solution is clarified by sedimentation in the settling vat, the clear liquor is returned to the boiler, *tor* or mother-liquor is added, and salt is educed by concentrating the mixture.

A Government tax of R1-8 has to be paid by the refiner for each maund of common salt made in his factory, and it is sold at the rate of R1-9 to R1-12 per maund.

A table of analyses, Statement IV, is appended showing the composition of *sitta*. The following table, Statement V, gives the analyses of fourteen samples of *sitta* made by Dr. J. Walter Leather, Agricultural Chemist to the Government of India. It will be noticed that in some instances a large proportion of the chloride exists as a potassium salt.

STATEMENT IV.—*Analyses of Impure Salt* (*Sitta*).

Register No. of sample in the office of the Agricultural Chemist to the Government of India.	Source of Sample.	Moisture.	Alkaline Chlorides.	Sodium Sulphate.	Nitrates and other salts.	Insoluble.
386	Jajmou, Cawnpore .	2·80	71·00	6·40	13·60	6·20
391	Kheora (1), Cawnpore .	5·40	58·50	4·93	29·07	2·10
397	„ (2), „ .	1·90	57·93	7·61	18·66	13·90
428	Etah	7·20	51·12	11·44	27·54	2·80
453	Muttra . . .	7·60	64·68	7·92	17·70	12·20
486	Hansi, Hissar . .	3·30	85·20	4·66	6·84	...
666	Hardoi, R1-2 . .	5·70	59·92	3·41	26·77	4·20
670	Farrukhabad, R1-2 .	2·80	70·00	5·56	17·04	4·60
721	Okara, Panjab . .	7·00	72·50	3·64	14·76	2·10
731	Bhawani, Panjab . .	6·10	59·16	19·24	13·90	2·60
739	Sirsa, Hissar, Panjab .	7·60	49·88	16·80	21·12	4·60
746	Shahpur, Panjab . .	6·20	70·68	4·12	16·50	2·50
757	Lalganj, Saran . .	9·40	30·16	18·76	29·08	12·60
773	Ramchandarpur, Muzaffarpur.	7·80	26·68	38·24	19·38	7·90

STATEMENT V.

	1318-04.	1319-04.	1320-04.	1321-04.	1322-04.	1323-04.	1324-04.	1325-04.	1326-04.	1327-04.	1328-04.	1329-04.	1330-04.	1331-04.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Sitta- Impure salt by-product of a saltpetre refinery—Sikandra Rao, Aligarh District.	Sitta—Impure salt by-product of a saltpetre refinery – Farukhabad.	Sitta—Impure salt by-product of a saltpetre refinery – Farukhabad (*Note I*).	Sitta—Impure salt by-product of a saltpetre refinery—Muttra.	Sitta—Impure salt by-product of a saltpetre refinery—Produced at Sirsa-Hissar.	Sitta—Impure salt by-product of a saltpetre refinery at Khoie, Ferozepore.	Sitta About 80 per cent. chloride of sodium. Impure saltpetre salt by-product of a saltpetre refinery, Okarar, Montgomery.	Sitta—About 80 per cent. sodic chloride Impure salt by-product of a saltpetre refinery Farukhabad.	Sitta—About 80 per cent sodic chloride. Impure salt by-product of a saltpetre refinery—Ghatiaghat Farukhabad.	Sitta—Produced at Laldarwaza refinery—Farukhabad.	Sitta—About 80 per cent. sodic chloride. Impure salt by-product of a saltpetre refinery Bakramow, Farukhabad.	Sitta—Monghyr Circle.	Sitta – Patna Circle.	Sitta—Saran Circle.
Potassium Nitrate . .	10·78	14·49	13·04	14·90	13·78	12·48	2·67	4·84	11·16	12·39	6·70	14·22	8·20	4·35
„ Sulphate. .	6·70	8·72	8·03	3·68	11·09	24·47	6·71	5·96	8·98	7·03	6·90	21·40	21·10	6·46
„ Chloride . .	28·27	19·90	9·06	22·97	3·40	...	3·11	...	23·88	24·42	26·11	...	...	...
Sodium Sulphate . .	...	...	...	...	...	·78	...	5·60	...	...	...	2·62	5·14	6·64
„ Chloride . .	43·01	42·08	58·85	35·80	60·24	40·17	77·70	74·33	39·14	43·20	46·75	36·71	44·52	42·56
Water	6·70	10·64	7·63	15·72	3·42	8·22	·39	5·98	11·54	9·07	9·86	10·84	6·31	6·38
Organic matter . .	·34	·02	·11	·18	·34	·64	·31	·21	·39	·18	·21	·87	·70	·96
Sand	3·15	1·54	2·34	5·29	6·10	13·39	8·15	·95	1·95	2·66	2·04	12·06	13·16	31·29

Note I.—This is more saline than the ordinary "*Sitta*" produced in the Farukhabad Refineries.

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Saltpetre salt.

In Statement VI the analyses of twenty samples of refinery or saltpetre salt are shown. The samples were obtained from Northern India and Bihar. The percentage of chloride varies from 69·44 per cent. in an illicit sample from Sewan to 97·2 per cent. in a sample obtained from Montgomery, Panjab. More than half the samples contained over 90 per cent. Some of the samples are clean and white, and the crystals are dry and uniform. There is nothing injurious to health in the composition of the best samples. Those containing high percentages of nitre might be viewed, however, with some suspicion for household purposes.

The actual values of certain samples were given by officers of the Salt Department, and the analyses show that the prices vary in accordance with the quality.

STATEMENT VI.—*Analyses of Refinery Salt.*

Register No. of sample in the office of the Agricultural Chemist to the Government of India.	Source of Sample.	Moisture	Alkaline Chlorides.	Sodium Sulphate.	Nitrates and other salts.	Insoluble.
387	Jajmou, Cawnpore	2·20	93·15	...	4·65	..
392	Kheora (1) ,,	·70	95·42	1·34	2·54	...
398	,, (2) ,,	2·80	94·52	2·68	...	...
426	Etah, good quality	1·80	85·20	3·02	9·93	·70
427	,, inferior ,,	2·90	76·11	9·38	11·11	·50
451	Muttra, good quality	1·10	96·68	1·08	1·14	...
452	,, inferior ,,	4·70	78·79	3·52	12·79	·20
652	Sewan, Saran, *kuthia*	1·40	95·85	·24	3·11	...
653	,, ,, *dhulia*	1·40	96·43	·48	1·69	...
658	Dindialpur, Saran, *kuthia*	1·00	92·22	1·68	5·10	...
661	Sewan, Saran (Illicit)	7·20	69·44	8·22	11·44	3·70
867	Hardoi, superior, R2-10	2·60	92·12	1·68	3·10	·50
665	,, inferior, R2-9	3·40	86·24	4·40	5·96	...
668	Farukhabad, superior, R2-14-6.	1·90	95·51	1·95	·64	...
669	Farukhabad, inferior	5·50	82·88	6·82	3·69	1·10
676	Gurwa, Ghazipur, R2-10—R3.	1·60	94·03	1·21	2·26	·90
724	Okara, Montgomery, Panjab.	2·80	97·20	tr.	tr.	...
756	Lalganj, Saran	6·90	75·98	9·00	8·12	...
772	Parsanni, Muzaffarpur	2·90	89·90	2·64	4·26	·30
774	Mankapur, ,, (Illicit)	2·80	84·10	7·28	4·80	1·40

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By-products.

Other By-Products.

Except *sitta*, and the common salt made from it, the by-products of the refinery are not of very great importance. The scum which forms on the surface of the boiling nitre liquor is called by various names, such as *zag*, *zoga, mail*, and *phain*. Samples of this product from Kheora and Hansi have been examined, and they have been found to consist chemically of potassium, magnesium and calcium salts, combined as chloride, sulphate and nitrate. These salts were combined with organic matter derived from vegetable débris ; the scum is a mixture of crystalline salts and vegetable or organic remains. It contains nitrates mostly of calcium and magnesium.

The two samples were composed as follows :—

	Kheora.	Hansi.
Water	3·90	5·40
Loss on ignition	20·85	22·10
Sodium chloride	51·97	35·28
Sodium sulphate	4·57	3·29
Nitrates of potassium, calcium and magnesium	18·71	33·93
	100·00	100·00

Mattiaree.

Mattiaree is the Hansi name of the deposit left at the bottom of the settling tank when the nitre liquor has been decanted into the crystallising vats. This consists for the most part of sulphate of calcium, chloride and nitrate of potassium, calcium and magnesium.

Mattiar.

Mattiar in Bihar is the name of the residual nitrous earth left after the process of leaching.

Trade.

Trade.

As regards the trade in saltpetre, the subjoined tabulated statement of quinquennial averages compiled by the Commissioner, Northern India Salt Revenue, shows what the exports from India have been during the past 50 years.

	Average annual export, cwt.	Average value per cwt. R	a.	p.
1853-54—1857-58	606,624	7	14	1
1858-59—1862-63	631,281	10	17	7
1863-64—1867-68	417,895	11	8	3
1868-69—1872-73	464,253	8	15	4
1873-74—1877-78	454,965	9	2	2
1878-79—1882-83	399,839	9	10	7
1883-84—1887-88	425,945	9	6	2
1888-89—1892-93	815,107	9	9	11
1893-94—1897-98	408,585	11	0	8
1898-99—1902-03	374,810	9	15	0

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Trade.

In 1859 a duty of 3 per cent *ad valorem* was imposed on the export of saltpetre. This light tax did not affect the trade prejudicially, though there was some rise in price. In 1860-61 an export duty of R2 was levied and this was maintained until 1864-65. This heavy duty was severely felt, and in consequence of its imposition, prices rose considerably, and the trade declined. In 1865-66 the duty was reduced to one rupee per maund, and this was followed next year by a reversion to the 3 per cent. *ad valorem* rate. In the following year (1867-68) the duty was entirely removed, but the trade was unable to recover from the effects of the high rate of duty levied during the six years from 1860-61 to 1865-66. The failure of the trade to recover its former position was probably due to the fact that the high prices imparted a stimulus to scientific enquiry for substances which might supersede the use of natural saltpetre, and this led to the production of saltpetre artificially from the decomposition of sodium nitrate and potassium chloride. Again the manufacture of high explosives such as cordite has largely tended to depress the use of black powder in warfare, sport and blasting.

Effect of duty.

Artificial saltpetre.

Under these circumstances the Indian saltpetre trade has held its own better than might have been expected. There has been a decline in the export during the past few years, but the trade is subject to fluctuations and a revival is possible at any time. The Director General of Statistics in 1902 pointed out that the Indian market is affected favourably or unfavourably by the fluctuations in the artificial saltpetre trade to which it responds. If the competition of artificial saltpetre did not exist, the Indian trade would be steady and progressive despite the excise system. It has been remarked that the Indian trade has been depressed within recent years owing to the increased use in the United Kingdom and America of bone manure which seems to be taking the place there of nitrous manures. But this explanation is not conclusive.

In the Far East the exports of Indian saltpetre to China have grown steadily up during the same period. In Japan, however, owing to cheap freight and the fact that German artificial saltpetre is admitted at half the rate of duty than the Indian commodity has to pay, the exports from India during the quinquennial period 1896-97—1900-01 have fallen from 246 to 61 tons.

The total exports of saltpetre from British India during the five years ending with 1900-01 amounted to 2,055,267 cwt., while the registered production for the same period in Northern India and Madras was 2,046,899 cwt. (2,786,058 maunds). Even allowing for

stocks held previously and for errors in registration it would appear that the demand for saltpetre in the country is comparatively small, and that the industry is regulated almost entirely by the requirements of foreign trade.

Saltpetre manufacturers.

List of Leading Manufacturers of Refined Saltpetre in the Panjab, the United Provinces, and Bihar.

1. Behari Lal, Mohalla Lal Darwaza, Post Office Farukhabad, District Farukhabad (United Provinces).
2. Bolaki Das, Mohalla Wrightganj, Post Office Farukhabad, District Farukhabad (United Provinces).
3. Pirag Das, Mohalla Bakramow, Post Office Farukhabad, District Farukhabad (United Provinces).
4. Gopi Nath Badri Das, Mohalla Ghatiaghat, Post Office Farukhabad, District Farukhabad (United Provinces).
5. Gokal Chand, Mohalla Khanpur, Post Office Farukhabad, District Farukhabad (United Provinces).
6. Gurmuk Rai Durga Pershad, Village Jajmou, Post Office Cawnpore, District Cawnpore.
7. Baigu Lal, Village Raipur, Post Office Akbarpur, District Cawnpore (United Provinces).
8. Sham Lal, Village Hardoi, District Hardoi (United Provinces).
9. Chotey Lal, Village and Post Office Khyrabad, District Sitapur (United Provinces).
10. Bhai Lall, Village and Post Office Seramow, District Shahjahanpur (United Provinces).
11. Sheo Narain, Village and Post Office Sirsa, District Hissar (Panjab).
12. Ramji Das, Village Khaie, Post Office Ferozpore, District Ferozpore (Panjab).
13. D. McLeod, Village and Post Office Okara, District Montgomery, (Panjab).
14. Ramnarain, Village Sohagpur, Post Office Hathwa, District Saran (Bihar).
15. Lachmi Pershad, Village Dataganj, Post Office Chapra, District Saran (Bihar).
16. Saligram Mehto, Village Devaria, Post Office Enai, District Saran (Bihar).
17. Sheikh Mehboob Raza, Village Savan, Post Office Savan, District Saran (Bihar).
18. Khoob Lal, Village Bhatolia, Post Office Paroo, District Muzaffarpur (Bihar).
19. Raikharam, Village Karnawl, Post Office Sahibganj, District Muzaffarpur (Bihar).
20. Bhondoolal, Village Raini, Post Office Sakra, District Muzaffarpur (Bihar).

21. Musst. Bholia, Village Surmastpur, Post Office Chandanputti, District Muzaffarpur (Bihar).
22 Gokhal Sahu, Village Surmastpur, Post Office Chandanputti, District Muzaffarpur (Bihar).
23. Beharilal Sahu, Village Pursal, Post Office Katra, District Muzaffarpur (Bihar).
24. Kewalput Sahu, Village Pursal, Post Office Katra, District Muzaffarpur (Bihar).
25. Narain Sahu, Village Bundhu Patti, Post Office Kamtoul, District Darbhanga (Bihar).
26. Ram Lal, Village Bundhu Patti, Post Office Kamtoul, District Darbhanga (Bihar).
27. Doma, Village Gobindpur Behta, Post Office Darbhanga, District Darbhanga (Bihar).
28. Dwarka Pershad, Village Mow, Post Office Mow Bazidpur, District Darbhanga (Bihar).
29. Laltapershad Jhabbu Lal & Coy. Sekandra Rao, Aligarh.

Saltpetre as a Manure.

Saltpetre as a manure.

Nitrous earth is used as a manure by cultivators in tracts where there is an available local supply. In Bihar cultivators employ it as a fertilizer in poppy cultivations. In the United Provinces, cultivators utilize as much as they can obtain for wheat, potatoes and other crops. In the Tinnevelly District of Madras, nitrous earth is employed as a manure for tobacco, millets and garden crops. Dr. Leather in three samples of this earth found ·78, 1·05 and 1·78 per cent of potassium nitrate. Many trials of crude saltpetre alone, and in combination with bone-dust and superphosphate, have been made at Government Experimental Farms. At the Cawnpore Farm, twenty years' experiments have shown that saltpetre increases the yield per acre of maize from 740 to 1,020 lbs. and of wheat from 1,270 to 1,710 lbs. (see N.-W. P. Bulletin No. 9 of 1900). Similar experiments at the Nagpur Farm have given an increased yield per acre of wheat from 420 to 870 lbs. At the *Dumraon* farm, saltpetre has increased the yield of paddy from 950 to 1,440 lbs. per acre, and has given good results for wheat (see *Agricultural Ledger* No. 10 of 1893). The best results have been obtained from twelve years' experiments at the Burdwan Farm, where saltpetre has increased the yield of paddy from 1,480 to 4,350 lbs., giving a profit of Rs. 105 per acre for an outlay of Rs. 9-4 on saltpetre. It has also given excellent results when tried upon jute and sugarcane. Experiments at Poona and Surat have also shown that saltpetre is a successful manure for rice. Saltpetre has thus almost uniformly proved itself directly valuable as a manure for cereal crops, which was to be expected when the average refined

Saltpetre as a manure.

material contains about 12 per cent of nitrogen and 43 per cent of potash. With an advance of agricultural methods, there should be a considerable expansion in the use of saltpetre as a fertilizer, but under present conditions its extended use is hampered by its price, the cost of railway freight over long distances and the fact that there is no guarantee as to its purity. Indian saltpetre (potassium nitrate) is more valuable than Chili saltpetre (nitrate of soda) in various industries, so that its price is regulated by the export trade and is independent of agriculture.

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G. I. C. P. O.—No. 1401 R. E. P.—19-9-1905.—2,500.—P. M. M.

(Vegetable Product Series, No. 91.)

THE AGRICULTURAL LEDGER.

1905—No. 4.

MALLOTUS PHILIPPINENSIS.

(KAMALA.)

[*Dictionary of Economic Products, Vol. V.*, M. 71-86.]

Other DICTIONARY articles that may be consulted :

Flemingia congesta, Vol. III., F. 633—642.
Agricultural Ledger, No. 16 of 1898.

The collection and composition of the dye stuff Kamala, by the Officiating Reporter on Economic Products to the Government of India.

Introduction.

Attention has often been directed to the subject of the red dye produced from the glands of the mature fruit of **Mallotus philippinensis**, commonly known by the vernacular name of *kamala*. Its use in medicine is now almost obsolete, and the drug was omitted from the *British Pharmacopœia* of 1898, but there is still a favourable opinion among Indian dyers on its tinctorial properties. Ten years ago a consignment was forwarded to Messrs. Gehe & Co., of Dresden, to ascertain the commercial value of the dye. It was favourably reported on and resulted in an order for 20 cwts. The gross adulteration to which *kamala* is often subjected is a strong reason for the lack of interest which it has received in the trade. A product indigenous to nearly all parts of India should not be allowed to disappear. At the request of the Inspector-General of Forests *kamala* was included by the Reporter on Economic Products in the programme of collections for the year 1898-99, and specimens and information were called for from the chief divisions.

The present *Agricultural Ledger* embraces the results of the enquiries collected from forest officers in all parts of India, and these are published together with the conclusions of the technical researches of Mr. A. G. Perkin of the Yorkshire College, Leeds.

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Vernacular names.

Mallotus philippinensis, *Muell. Arg.; Fl. Br. Ind., V., 442; Ind. Kew., III., 150.*

THE MONKEY FACE TREE.

Syn.—ROTTLERA TINCTORIA, *Roxb.;* R. AURANTIACA, *Hook. and Arn.;* R. AFFINIS, *Hassk.;* R. MONTANA and MOLLIS, *Wall.;* CROTON PHILIPPINENSIS, *Lamk.;* C. PUNCTATUS, *Retz.;* C. COCCINEUS, *Vahl.;* C. MONTANUS, *Willd;* C. DISTANS, *Wall.;* C. CASCARILLOIDES, *Rauesch.*

Vern.—*Kambilá, kamúd, kamalá, kamilá, kamelá, rúin, rúlú, kambhal, wussantha-ganda* (powder), HIND.; *Rori* (LOHARDUGGA); *Dhola sindur* (BIRBHUM); *Sinduri* (DARJEELING); *Kamila, túng* (*kishur* or *késar* = saffron), *kamalá guri* (the dye powder), gundi, *kamalá gundi,* BENG.; *Kumala, súndra gundi, bosonto-gundi,* URIYA; *Rora,* SANTAL; *Gangai, puddum, jaggarú, hibang, jarad,* (also for annatto) *lasson,* ASSAM; *Chinderpang, machugan,* GARO; *Sinduria, safed mallata,* NEPAL; *Puroa, tukla, numboongkor,* LEPCHA; *Baraiburi, sindurpong,* MICHI; *Koku,* GOND; *Reoni, roli, kamela* (BANDA); *Ruinia, Kamela* (BIJNOUR); *Rori* (BUNDELKHAND); *Sindúria, puroahung, rohini, rohni, ruina, sundri, kamela, raini, raweni, sindhari,* U. P.; *Rohni* (OUDH); *Rúen, riúna, roli, rauni, rerú,* KUMAON; *Kaimbil,* KASHMIR; *kamela, kamal, kamila,* or *kambila, kahmla, kámal, kambal, kúmila, reini, reun, rúlya,* PB.; *Kámbaila* (PESHAWAR), PUSHTU; *Rauni, rori, chamar gular, ningur, kamella, sendúr, shendur, kúnkú, sindhur, roru,* or *rori, kamela,* C. P.; *kokhu kuku, sendri, kamela* (MELGHAT) BERARS; *shendri, kapela, kamala, kunkuma, kapil,* BOMB.; *shendri, shindur,* MAR.; *kapilo,* GUZ.; *kapli, kapila, kamela-mavu* (? pod = pollen), *thavittai, kuran gumanjanathi kapila rung, kapilapodi, thiruchúrna maram,* TAM.; *kúnkuma, kapila, vassuntagunda* (powder), *chendra-sinduri, sundra gundi,* TEL.; *Kurku, rangamále, corunga-manje, sarnakasari, hulichellu, kunkuma, kasalay, kesalay, kamela,* KAN.; *Ponnagam* (? CALOPHYLLUM INOPHYLLUM), MALAY; *Tawtee-cteng, tan-thieden, tawthidin, pothidin, thidinhmok* (the dye) BURM.; *Tawthadin,* SHAN; *Hamparandella,* SING.; *kapila, kampilla* (the red mealy powder), *rechanaka* (*Punnaga* is incorrectly given in many books as Sanskrit for this plant,—see CALOPHYLLUM INOPHYLLUM), SANS.; *Kinbil* (a word derived from the Sanskrit and now restricted in India to this plant), ARAB.; *Kanbélá,* PERS.

Dr. Buchanan-Hamilton called the tree *corunga munji maram* or "Monkey face tree," because these animals paint their faces red by rubbing them with the fruit.

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References.

References.—*Roxb. Fl. Ind., Ed., C.B.C., 737; Brandis, For. Fl., 444; Kurz, For. Fl. Burm., II., 381; Beddome, Fl. Sylv. t. 289; Gamble Man. Timb., 361; Dalz. and Gibs, Bomb., Fl., 230; Stewart, Pb. Pl., 197; Grah., Cat. Bomb. Pl., 184; Mason, Burma and its People, 512, 543, 761; Benth., Fl. Hongk, 307; Hooker, Him. Journ. I., 315; Miquel, Fl. Ind. Bat. Suppl., 454; Rheede, Hort. Mal., V., t. 21, 24; Elliot, Flora Andhrica, 36, 86, 95, 96, 98, 103, 151, 168, 185, 189, 190; Pharm. Ind., 202; British Pharm., 167; Moodeen Sheriff, Supp. Pharm. Ind., 170; U.C. Dutt, Mat. Med. Hind., 232, 302; Dymock, Mat. Med. W. Ind., 2nd Ed., 709; Flück. and Hanb., Pharmacog., 572-576; Pharmacog. Ind., Vol. III, 296; U.S. Dispens., 15th Ed., 828; Bent. and Trim., Med. Pl., IV., t. 236; Murray, Pl., and Drugs, Sind, 34; Med. Top. Ajm., 142; Irvine, Mat. Med. Pat., 48; Buchanan, Journey through Mysore, Canara, etc., I, 168, 204, 211; II., 343; Baden-Powell, Pb. Prod., 376; Atkinson, Him. Dist., 776; Drury, U. Pl., 285; Lisboa, U. Pl. Bomb., 122, 248, 258, 268, 275; Birdwood, Bomb. Pr., 78, 301, 336; Royle, Ill. Him. Bot., 329; McCann, Dyes and Tans, Beng., 18-20; Buck, Dyes and Tans, N.-W. P., 31; Liotard, Dyes, 56-58, 89, 90, 125; Wardle, Report on India Dyes, p. 5; Darrah, Note on Cotton in Assam, 33; Aplin, Report on the Shan States, 1887-88; Prof. Hummel, (Special Report in connection with Colonial and Indian Exhib.); Kew Reports, 81, 50; Kew Off. Guide to the Mus. of Ec. Bot., 119; For. Admn. Report Chutia-Nagpore, 1885, 34; Bomb. Gaz., XI., 25; XV., i., 75; Lamk, Encycl., II., 206; Indian Forester, Vol. III., 24, 204; Vol. IV., 230, 318, 323; VIII., 106, 119; IX., 413; X., 33, 325; XI., 367; XII, 188 (XXII.); XIII., 121; Gazetteers:—N. W. P., I., 34; II., 173; IV., 77; X., 317; Bombay, XV., 72; XVII., 26; Pánjab, Hoshiarpur District, 10; Ráwal-pindi District, 15, 83; Peshawar District, 2; Mysore and Coorg, I., 48, 436; II., 7; III., 22; Hunter, Orissa, II., 179, Ap. VI.; Manual of the Cuddapah District, 200; Settlement Report of the Upper Godávery District, 38; Central Provs. (Raipur Dist.), 76; (Chanda District), Ap. VI.; Agri.-Hort. Soc. (Old Series), IV., Pt. I., 210, 211; VI., Pt. I., 27; VIII. Sel., 178; XIII., 314, 353, 390, 391; XIV., 21, (New Series) I., 103; VI., Sel., 20; Honigberger, Thirty-five years in the East, 337.*

Habitat.

Habitat.—The major portion of the new information in this revision has been derived from correspondence with the Forest officers in the provinces named.

A small, evergreen tree, found throughout tropical India; along the foot of the Himálaya from Káshmir eastwards (ascending to 5,000 feet); all over Bengal and Burma, Singapore, and the

Habitat.

Andaman Islands; and from Sind southwards to Ceylon. Distributed to China, the Malay Islands, and Australia.

Bengal.

Bengal.—The tree is fairly abundant in the forests of Puri and Singhboom, but is scarce in other localities. A later report from the Puri Division states the plant occurs in abundance in the southern portions of the district. It grows wild in the forests. The tree attains its greatest perfection in open situations. It flowers and fruits heavily on lands leased to the Khonds, who clear away all other tree growth, and carefully prune the trees every year. On these lands the Khonds raise oil-seeds, Eleusine and Phaseolus. But in the thick forest the trees bear few flowers and fruits. The tree attains a height of about 40 feet with girth of about 4 feet. It flowers in December and fruits in January-February.

Assam.

Assam.—The tree grows wild on lands in Darrang above flood level containing very little humus. It is not abundant. The greatest height observed is 40 feet, with 3 feet girth. Reported to occur in the Jorhât Sub-Division where it is known as Assamese or male *Jarat* in contradistinction to Bengal or female *Jarat* or **Bixa Orellana** (Arnatto). The plant is not uncommon in the Nowgong District, where it is found wild on *basti* or high land.

United Provinces.

United Provinces.—**Mallotus philippinensis** is found in great quantity throughout the Kumaon, Garhwal, and Ganges Sub-Himalayan Forest Divisions. It is extremely abundant in the districts of Kheri, Bahraich, and Gonda and less so in Pilibhit and Gorakhpur. The tree grows wild, for the most part associated with *Sál* (**Shorea robusta**), where it often forms a dense undergrowth. It prefers a porous well drained soil, and is partial to a large admixture of vegetable mould. In favourable circumstances the tree attains a height of 35 feet and girth of 3 feet. Sowings of the tree at Bahraich by the Forest Department have more than once failed, and it was decided in 1899 not to renew them. The tree coppices most profusely, and is a source of some annoyance in *Sál* forests. The tree is common in the Dun; in a few places, aggregating perhaps 3 square miles, it is concentrated, and may be said to form almost the principal species. It occurs sparsely to very sparsely in the *Sál* forests, and in greater numbers in the smaller Kokat forests. It thrives best in the lower levels, and within reach of water, it does not do well with *Sál*, the shade of which is probably heavy for it. The greatest proportions it attains as a general rule are 4 feet in girth and 30 feet in height. It is also found in the Banda District.

Central Provinces.

Central Provinces.—The tree is reported not to occur in the Bhandara and Chhindwara Divisions. In the Nagpur Wardha Division only one small tree was found; height 11 feet. In

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the other six divisions, the tree is found in small numbers. The following is an abstract of reports furnished by Forest Divisional Officers. Grows wild but not in any abundance on the banks of rivers and *nalas*. Attains a height of 25 to 30 feet with a girth of 6—7 feet (Balaghat). The tree is not common; grows wild along the banks of big *nalas*. Trees are known as high as 25 to 40 feet with a girth of 4 feet. It flowers and fruits in the cold season (Bilaspur). Very seldom met with in Chanda. It is uncommon in Raipur. It grows in sandy soil and attains a height of 20 feet with a girth of 3 feet. Not found in abundance in Seoni. Occurs in dry soil below the hills. Trees as high as 20 to 25 feet with girth of 2½ feet are met with. Met with here and there throughout the Damoh District, but is nowhere very plentiful. It occurs wild, generally on low-lying ground in the neighbourhood of streams and rivers, where the soil is usually of good quality, often mixed with *kunkur*, and contains a fair amount of moisture. The height of the tree varies from 15 to 25 feet, and its greatest girth is usually 3—4 feet. Old pollarded trees of 8—9 feet in girth are occasionally found. The tree is associated with *Katjamun* (**Eugenia salicifolia**) and *Koha* (**Terminalia Arjuna**). Found in only one place in Narsinghpur on the banks of the Nerbudda River. The trees are far from vigorous. Height attained is from 15 to 22 feet with girth of from 18 to 24 inches. Occurs on fairly level ground consisting of a deep sandy loam.

Ajmer.

Ajmer.—The Extra Assistant Conservator of Forests, Ajmer-Merwara, reports that **Mallotus philippinensis** does not grow in the forests of his division.

Panjab.

Panjab.—Found scantily in a few forests near Khanpur, in the Hazara Forest Division. The geatest girth and height it attains to are 2 and 15 feet, respectively. The tree is found throughout the lower hills near Rawalpindi up to about 5,000 feet. It is most plentiful in the Marrgolle Reserve about 12 miles from Rawalpindi. It frequents the cooler aspects and *nalas*. The tree is not cultivated. The maximum size it attains is 15 feet high and 3 feet girth. Is common along the Rávi River to about 15 miles above Chamba. Grows wild as a large shrub or a small tree. Is most abundant in the dry, low hills, particularly near rivers, and appears to thrive best between 2,000 and 4,000 feet, but is found up to 6,000 feet. Its height has not been observed to exceed 25 feet. Very common in the Nurpur Tehsil of the Kangra District. Grows wild all over the scrub forests and often forms part of the undergrowth on open *chil* forests. One of the commonest species in the Nurpur Forests, it occurs up to an altitude of a little over 2,500 feet. The tree grows in abundance in the Simla District. It is met with

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Panjab.

on hilly ground and in gravely black loamy soil. The greatest height and girth observed are 30 feet and 3 feet, respectively.

Bombay.

Bombay.—In the Southern Circle the tree is found chiefly in the more open jungles of the Belgaum Taluka and Chandgad Mahal. Met with only occasionally in the Khanapur Taluka. The tree is plentiful in places in the south-west portion of the taluka. Met with at altitudes of about 2,000 feet, both on hill sides, and along rocky *nala* beds, which are dry for a greater part of the year. The tree attains a girth of 4 feet with height of 15 to 18 feet. (Belgaum). Found only in the evergreen belt of the Matheran slopes, the upper slopes of the Ghats in the Karjat, Kholapur and Nagotna Ranges, and does not grow in abundance in the district. Met with in a wild state and almost always at or round the heads of ravines. The plant does not reach any great size in the Kolaba Division. It is reported not to occur in the forests of the Central Circle of Bombay.

Berar.

Hyderabad Assigned Districts.—Is fairly common on high plateau in the Melghat Tahsil, but is rare below 2,500 feet elevation in the Ellichpur Division. The tree is a small one, and never exceeds 35 feet in height and 3 feet in girth. It reproduces itself naturally by seed, and is not cultivated. It is found along the Penganga River in the Kinwat Reserve, but not abundantly in the Basim Division. The tree occurs wild in loose soil along banks of *nalas*. Average height and girth 12 feet and 3 feet, respectively.

Madras.

Madras.—**Mallotus philippinensis** is found widely distributed in the Gamsur taluk of the Ganjam District, and elsewhere in small groups, or as isolated trees along shady water courses. It is also found on the Ramandrug plateau in Bellary. In Ganjam it is met with in and near the cultivated fields, it being kept as a standard tree over field crops. In Bellary, on the plateau and slopes of the Sondar Hills, loose red soil is most suitable for its growth. Maximum height to which it attains about 40 feet, with girth of about 4 feet. Not abundant. Occurs here and there in the Javadis, Chitteris, Shevaroys and Kollimalai Hills of the Salem District. On the Chitteri Hills trees measuring 4 feet in girth and 30 feet in height are met with. The tree occurs in abundance in the Doddasampagai and Madiswaran Malai Reserve in North Coimbatore. It grows wild in valleys and hollows where the soil is moist. Trees of 30 feet height and 3 feet girth are known, but the Sholagars report that larger trees exist in the Doddasampagai Reserve. **Mallotus philippinensis** is believed not to occur elsewhere in the North Coimbatore District. It is scarcely met with in some parts of the Vellapathy block in the south of the district. It occurs

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Madras.

generally in the plains and in black soil, attaining a height of about 30 feet with girth of about 2½ feet.

In Madura **Mallotus** occurs chiefly at the foot of the hills and is found up to an elevation of 3,500 feet. It is not very abundant and is mixed with such plants as **Kydia, Nux-Vomica, Amoora,** and **Zizyphus**. In the higher regions it occurs as a straggler in the deciduous forest, associated with **Anogeissus** and teak. It is not found in evergreen forest. The largest tree in the hills had a height of 30 feet, bole of 10 feet, and a girth a 33 inch. At the foot of the hills the following dimensions were observed: height 18 feet, bole 5 feet, and girth 24 inches. The tree is not abundant nor yet uncommon throughout Tinnevelly. It is found scattered on the Ghat forests and the Taluks along the Ghats. The tree grows wild in deciduous as well as in evergreen forests of low altitudes. In the latter it flourishes in spots abandoned after cultivation. Average height 20 feet; girth 2 to 2½ feet.

Burma.

Burma.—Kurz remarks that " **Mallotus** is frequent especially in the dry and low forests, all over Burma from Ava and Chittagong down to Tenasserim and the Andamans, ascending into the hill Eng Forests up to 2,000 feet elevation." The tree is found very sparsely in the Tharrawaddy District. It grows wild in moist forest, but was formerly cultivated to a small extent. Average height 23 feet with girth of 3—4 feet. The tree does not seem to grow in very great abundance. Said not to be so common as it is in Upper Burma. It seems to do best in moist sandy soils. It flowers in the rains and fruits in the cold season. The tree is rarely met with in Prome. It grows wild in low moist localities, greatest height 30 feet, girth 4 feet. **Mallotus philippinensis** is found in the hill forests of Bassein, Myaungmya Division, to a very small extent. It is found chiefly at the foot of the Yoma hills. Reported not to be known in the Upper Chhindwin Division. It is common but is not used for the manufacture of dye or any other product in the Myittha Division. Occasionally found growing wild, but no dye is obtained from it, nor is it used for any purpose in Lower Chhindwin. Fairly common, but not abundant in Mu. Grows to a maximum height of 20 feet with a girth of 12 inches. **Mallotus philippinensis** is found only sparingly and of small size in Yaw Division. It requires a good deal of moisture with a not very high mean annual temperature, conditions not to be found in this Division except perhaps to the north of Gangaw. The tree is fairly well represented in Gangaw, and often attains a height of from 30 to 38 cubits with a girth of 4 to 5 feet. Generally speaking, however, it is a small tree or large shrub. It fruits profusely from the last week in February up to the end of March. Said not to be found in this Division (Minbu).

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MALLOTUS philippinensis. The collection and composition

Burma.

The tree is found sparingly throughout the Katha District. It grows wild in most forests and used to be cultivated. Maximum girth about 3 feet. The plant is said to be very scarce in the Ruby Mines Division. It has been found apparently wild on some old deserted paddy land near the town of Momeik, the altitude of which is about 500 feet. The tree does not exceed 25 to 35 feet in height with a trunk of 8 to 10 feet in length and 2½ to 3 feet in girth. The plant is not very plentiful in Pyinmana. It occurs in a wild state, scattered here and there, on the outskirts of villages and on the banks of streams; it is also found on the sites of deserted villages. It attains a height of 30 feet and a maximum girth of 3 feet. The seasons of flowering and fruiting of the *kamala* tree in Burma correspond with those in India.

Preparation.

Preparation of kamala.

The separation of the glands from the dried capsules is a matter of great simplicity, as it involves no skilled labour or special appliances. In the Oudh Circle, United Provinces, the fruit is spread on the ground and dried in the sun and then rubbed between the hands or sifted in a cloth. The berries denuded of their coloured coverings are thrown aside. At Dehra Dun the fruit is collected and dried in the sun and the red glands are rubbed off with the hand on a *pakka* or cement floor, or in a bamboo basket or cloth, and afterwards separated by being passed through a fine sieve. The fruit minus the glands is called *baiba rang* by the *paharis* or hill-men. Dr. Stewart states that the capsules, after being allowed to lie in a heap for a few hours, are rubbed or kneaded with the feet on the ground to remove the powder, the broken capsules being then separated by picking and winnowing. One man will collect a ser of powder in a day. The process necessarily admits of much admixture of dust, but the Bhoksas who prepare it in Kumaon deny that any adulteration takes place, and state that it reaches the market in the plains in a comparatively pure state.

In Berar and certain parts of the Madras Presidency the dried fruits are collected and shaken in a cloth, a bamboo basket, or a gunny bag, and the powder passing through is preserved. In Salem the fruits are rubbed together in a blanket, and the red powder, which is easily removed when dry, is collected and stored. In Coimbatore the dye is removed from the fruits by placing them on a clean floor and gently threshing them with a stick. The residue on the floor is then taken and passed through a sieve covered with a piece of muslin.

Some years ago in the Lahore bazar two kinds were sold, one was in a crude state, and the other had been passed through a coarse

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cloth to free it from impurities. It is the second kind which Baden-Powell calls *rulya,* a preparation containing 78 per cent. of colouring matter. Preparation. Rulya.

The work of preparing *kamala,* although not requiring any skill, is laborious and unremunerative. The collecting of it does not affect the prejudices of the higher caste in India, yet the industry is almost entirely in the hands of the more uncivilized tribes. The Khonds in Orissa, the Savaras in Ganjam, the Bhoksas in Oudh, the Chamars in Nurpur in the Panjab, and the Kols in the Central Provinces comprise the chief collectors. Some natives regard the beating of *kamala* fruits and winnowing of the powder as an occupation suitable only for women; in Bilaspur the men refuse to collect it, but permit their women to prepare it whenever there is a demand.

Yield.

Yield.

The amount of *kamala* afforded by a tree depends upon the size of the tree and the maturity of the capsules at the time of collecting. A well-known Conservator of Forests has observed that the fruit of the Bengal plant is much larger than that of the United Provinces, and doubtless yields more abundant and better colouring matter. Some attention to the tree would also benefit the yield, and it is known that the Khonds, who carefully prune the tree each year, secure more produce than other tribes. As noticed in the forest reports, the trees are always found in a wild state, and range in height from 15 to 17 feet to 40 feet, so that a uniformity of yield is not attained. The dye is washed off by the rains, and attrition of the capsules by violent storms, or movements of animals and birds cause a loss.

The following calculations were made a few years ago by Forest Officers in three selected districts. In Puri it was found that 70·56 sers of fruits were required to produce 1 ser of powder; this is equivalent to 1·41 per cent. Another experiment showed that 3·68 capsules yield 1 grain of dye. In Dehra Dun it was ascertained that 50 trees gave fruits weighing 7 maunds 23 sers, and produced 9½ sers of *kamala,* which is equal to 3 chittacks per tree, or 2·93 per cent. on the fruits. In the Bahraich Division, United Provinces, 80 sers of fresh fruits or 56 sers of dry fruits gave 2 sers 1 chittack of *kamala,* or 3·67 per cent.

From the Dehra Dun experiment which was undertaken with care, one tree will yield 6 ounces of *kamala* powder. In the Kangra District, where the plant grows freely, the average quantity of dye per tree is said to be 8 ounces. In the Puri Division of Bengal, in Berar, and in Salem the average yield is said to be one pound. An estimate of much over one pound of *kamala* per tree, in the light of

Average yield not more than one pound per tree.

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Average yield not more than one pound per tree.

this evidence, would be excessive, and the following large yields probably refer to the dried fruits and not the glands. Burma 7 to 14 pounds, Belgaum 12 to 15 pounds, Kollegal 10 pounds, Madras 7 to 8 pounds, United Provinces 3 to 4 pounds. On the other hand, we may take as correct the small yield in districts where the tree is stunted and scarce: Central Circle, Central Provinces, 1 to 1½ *tolas*;* Jubbalpur, "not more than two *tolas* from each tree;" Hazara, Panjab, "only a few *mashas* per tree" (*masha*=15 grains); Bassein, Berar, a "mature tree yields 5 *tolas*;" Prome in Burma, "5 to 10 ticals a tree in one year" (3 to 6 ounces).

Collecting areas.

Collecting areas and trade.

From a study of the distribution of the tree it will be seen that it is grouped or concentrated in about three or four centres where conditions of labour render it practicable to collect *kamala* for the market. The chief locality is in the hilly districts of Orissa and Ganjam, where the dye is collected by a jungle tribe called Khonds, now called Kandhs. The Kandhs are a Mongolo-Dravidian race numbering 612,483 at the census of 1901, and distributed in Madras, Bengal, and Central Provinces. They are a simple folk, and part with the powder to the low country native dealers settled amongst them for a few measures of rice or a yard or two of cloth. The output of the Ganjam-Gumsur forests in the north of the Madras Presidency is from 30,000 to 35,000 pounds, the cost price at Madras, including transport and delivery, is R20 to R40 per 100 lbs. In Ganjam 100 lbs. of powder could be delivered at Berhampore railway station or at Gopalpur, a sea-port town, at R12; this includes seignorage, cost of collection and transport. In Bengal, Puri, Singhbhum, and Jalpaiguri are considered the best places for collecting the dye, the tree being scarce elsewhere in the province. The dye was formerly procurable in large quantities from Raman Lall Das, of Elam bazar, Birbhum, at R13 to R14 per maund. Dr. Irvine in 1848 quotes 3 annas a pound (R15 a maund) as the price of *kamala* in the Patna bazar, indicating no fluctuation in value during the past half century.

United Provinces.

In the United Provinces, although extremely abundant in Oudh, it is reported that the dye is no longer used or exported from Northern India. About fifteen to twenty years ago (1878 to 1883) the product was leased out and large exports took place; at the present time we are assured that no collectors of *rohini* berries are found in the forests. In 1882 it was said that 2,000 maunds of dye were exported every year from the Kumaon forest division. The Bhoksas sold the powder to dealears for 5 sers the rupee. Dehra Dun

* 180 grains=1 tola, 5 tolas=1 chittack, 16 chittacks=1 ser (2¼lbs.)

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Trade, in value.

was formerly known for its *kamala* dye which was sold in the bazar at retail prices varying between 2 and 10 annas per ser. There is now no trade in the dye whether from Government or zamindari forests. One range officer reported that *Chamars* take the dye free from the latter forests, and after sifting it sell it in the Dehra bazar at 3 to 3½ annas per ser or a slightly higher rate. From an enquiry carried out by Mr. R. C. Milward he found the cost of extraction 3 to 6 annas per ser, but the cost of collection and materials for collection in areas where the trees grow thickly was R2⅓ per ser. At the instance of the North-West Soap Company in 1894, *kamala* powder was collected in the Dehra Dun Division at a cost of R31-8-0 for one maund and 7½ sers. (*Commercial Circular* No. 5 of 1895). It is said that 100 lbs. could be landed at a railway station for R10 to R12. With systematic working, about 1,000 maunds of powder could be produced from the Oudh Circle, but it would take time to arrange for such an output.

Central Provinces.

The *kamala* dye trade in the Central Provinces is unimportant. In the Southern Circle the dye is imported from Bombay and Cawnpore and sold by local *bunias* in small quantities. There is little local trade at Jubbalpur; small supplies are imported from Cawnpore and Northern India, and sold in the bazar at R12 to R24 per maund. Small quantities are exported to Berar and Nimar for dyeing silk. If a demand were to arise about 100 lbs. would cost R20 at the nearest railway station, but only a few maunds per annum could be expected from the jungles, where the Kols, a wild tribe near Sambalpur, prepare the powder.

Panjab.

Panjab.—The *kamala* tree is very abundant in the Nurpur forests, Kangra, and the dye is easily collected. About 30 maunds are annually exported from Nurpur, where it is sold more or less adulterated at the rate of 4 sers per rupee. The cost of 100 lbs. at Nurpur is R12-8, and this amount delivered at the nearest railway station, Patankot, would be R16. At Amritsar it is said to fetch R20 a maund. *Kamala* is imported into Rawalpindi from the Hosiarpur District at the latter price. The tree grows in abundance in the Simla forests, but the dye is not used. It is seen that the forests of the Punjab would be equal to supplying considerable amounts of *kamala* should there be a revival of the trade in India.

Bombay.

The Belgaum District in Bombay is the principal collecting ground for *kamala* in Western India. About 4,000 lbs. are collected and sold locally every year at 4 to 6 annas per pound. Including the yield of neighbouring talukas, the total outturn amounts to 5,000 and 6,000 pounds. The price of 100 pounds delivered at Belgaum railway station is R12-8. It is obtainable in the bazars all the year round. Dr. Dymock states that the average value of the

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best red *kamala* in Bombay in 1890 was R11 per maund of 41 pounds.

Berar.

Berar.—There is practically no trade now in *kamala* in the Hyderabad Assigned Districts. The trees are not plentiful and the price of the powder at 4 to 6 annas per pound barely pays the cost of collecting.

Madras.

Madras.—There is said to be no local demand for *kamala* in Madras City. The dye from Ganjam in the northern extent of the Presidency is all shipped to England and the Continent. The powder is collected in Salem by the Malayalis or hill men and sold to the traders at one rupee a Madras measure or 8 annas per pound. From here it is exported to the neighbouring districts of Tanjore and Trichinopoly for dyeing silk. The dye is extensively used in dyeing silk in Kollegal in the Coimbatore District. It is imported from Salem where it is sold for R7 per maund of 25 lbs. In Kollegal the maximum price varies between R20 to R25 per maund.

Mysore.

Mysore.—Dr. Buchanan-Hamilton relates that the *capily podi* or powder of the monkey-face tree was used and sold in different parts of Mysore and that it was brought from the Annimalais and hills on the western side of the plateau. The merchants of Bangalore bought up the dye from the *Chensus*, giving a *fanam* for one ser of the powder, or 1*s.* 1½*d.* a pound. The process of dyeing silk is described; it gave a pretty colour, fixed well, and was cheaper than lac.

Burma.

Burma.—The tree is more common in Upper than in Lower Burma, and far more common in the North-Western Provinces and Oudh than in any part of Burma. The dye collected in Burma is estimated to cost at least double what it does in North India. There is no export of *kamala* from the Bassein Division, but some years back the people living in the forest, west of the Yomas, used to rear silk-worms and dye the thread with the powder. There do not appear to be any regular market rates, but the prepared powder can be obtained in the jungles at R5 per viss. Those that require to use it send out their relations to collect it. In the Tharawaddy District there is no trade in the dye. That used locally comes from the Shan countries, but it is largely supplanted by dye from India.

Trade.

The annatto plant (**Bixa orellana**) known in Burma as *Engthidin* is considered to yield a better dye than *Taw-thi-din* (**Mallotus philippinensis**), and the products are often confused on account of the similarity of names, and because both are obtained from the fruit of the tree, and both are employed for silk dyeing.

Other Forest Divisions in Burma report that *kamala* is a useful dye for local purposes, but it is not sufficiently abundant for commercial use. The local prices 8 to 12 annas per pound, and

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for large quantities R50 to R75 per cwt., preclude any possibility of an export trade. Trade.

There is evidence on every hand that the internal trade in *kamala* is declining. In Murshidabad, the centre of the Bengal silk industry, annatto is superseding *kamala* for obvious reasons. In the first place annatto produces a brighter colour and in the second place it is cheaper. Although **Mallotus** produces a fast dye, it is difficult to obtain it unadulterated with brick dust, and the result is that instead of 20 maunds being used annually, the consumption has dwindled in all the dyeing districts. The cheapness of procuring aniline dyes has also had its effect; dyers now obtain the same colour with auroflavina, and with greater facility without the use of alum and other mordants. It is not of great moment whether the colour is fugitive or not so long as the process is cheap and the finished article is bright and attractive. Trade declining.

As the demand for *kamala* has declined the tribes who formerly prepared this minor forest product are abandoning the industry as a means of livelihood; the rate of about 2 annas a pound for collecting the powder offers no attraction to the *Chamars* of Northern India. In South India labour is more scare than formerly and the poorest castes refuse to engage in a laborious and unremunerative occupation such as the separation of *kamala* powder.

Referring to the recent market reports on the sales of *kamala* in London there is nothing to arouse any enthusiasm in the trade. In 1903 powder of fair quality was obtainable at 5*d*. and 6*d*. per pound, while in June lots of 'fair' sold for $3\frac{1}{2}$*d*. and rather sandy for $1\frac{1}{2}$*d*. per pound. In 1904 two quotations are given for 'good and bright' at 1*s*. 3*d*. and 9*d* per pound. For the first six months of 1905 *kamala* seems to have disappeared from the sale lists of the London drug market. London prices.

Chemical Composition.

Chemical Composition.

Kamala was first analysed by **Dr. Thomas Anderson** of Glasgow in 1855 who found the following constituents in 100 parts:— 78·19 of resinous colouring matter, 7·34 of albumen, 7·14 of cellulose, a trace of volatile oil, 3·84 of ashes, and 3·49 of water. Of the resinous colouring matters **Dr. Anderson** obtained one in a pure state by allowing a concentrated ethereal solution to stand for two days, drying and pressing in bibulous paper the resulting mass of granular crystals, and purifying them from adhering resin by repeated solution in ether and crystallisation. To this substance he gave the name of Rottlerin. It occurs in crystalline plates of a yellow colour insoluble in water, but soluble in alcohol, ether and alkaline solutions. The formula was $C_{11} H_{10} O_3$. Anderson's analysis.

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MALLOTUS philippinensis. **The collection and composition**

Chemical Composition.

Leube's analysis.

E. G. Leube, Jr., (*Jahresbericht*, 1860, 562), however, was unable to obtain any crystalline product, but he describes a resin melting at 80°, having the formala $C_{15} H_{18} O_4$, and a resin melting at 191°, of the formula $C_8 H_{12} O_5$. Oettingen of Russia, in 1862, was unable to obtain any crystalline substance from kamala.

Perkin's researches.

A. G. Perkin and W. H. Perkin, Jr., in 1886 made a preliminary examination of *kamala* and separated by means of carbon bisulphide a yellow crystalline body Mallotoxin. On pursuing the investigation, Mr. A. G. Perkin contributed a full account of the constituents in *Journ. Chem. Soc.* LXIII. (1893), pages 975—90. Rottlerin, the principal constituent, crystallises in salmon-coloured plates melting at 191-191·5°. When heated with caustic potash it yields benzoic acid, acetic acid and an amorphous substance. A resin of low melting point with the formula $C_{12} H_{12} O_3$ and closely associated with Rottlerin in many of its properties. When boiled with dilute alkalis the odour of benzaldehyde is noticeable.

A yellow crystalline colouring matter present in minute amount melting at 192-193°.

A wax, having a composition agreeing with the formula $C_{28} H_{54} O_2$, and melting at 82°, the melting point of cetylic cerotinate.

The residue left on extracting kamala with carbon bisulphide contains two substances isorottlerin and a resin of higher melting point both soluble in ether.

Isorottlerin crystallises in groups of minute plates melting at 198-199°. It differs from rottlerin by being practically insoluble in carbon bisulphide, chloroform and benzene.

The resin of high melting point is a pale yellow amorphous substance of the formula $C_{13}H_{12}O_4$.

In a subsequent paper on the chemistry of kamala [*Journ. Chem. Soc.* LXVII (1895), 230], Perkin continued the study of Rottlerin, the principal crystalline constituent, and showed the action upon it of nitric acid and sodium carbonate, the former yielding ortho and para-nitrocinnamic acids and the latter rottlerone. The yellow crystalline colouring matter contained more hydrogen than Rottlerin and is probably a reduction product of this body. The name homo-rottlerin was given to it.

In a further note on Rottlerin (*Journ. Chem Soc.* 1899. LXXV, page 827) Perkin deduced from analyses of its mono-substituted salts the formula $C_{33} H_{30} O_9$. It contains hydroxyl groups. By fusion with alkalis at 220-240° it yields acetic and benzoic acids together with phloroglucinol.

Adulteration.

Adulteration of kamala.

The impure state in which kamala is sent into the market either on account of careless collection or fraudulent admixture, must partly

account for its neglect by native dyers and the decrease in its use and trade in other countries. The presence of impurities has been detected by several chemists and has interfered with its proper examination. Dr. Leube, the German chemist, discovered the extraordinary proportion of 25·85 per cent. of ashes in a sample, and 83·8 per cent. consisted of insoluble silica. Perkin's researches in the drug were seriously delayed for the want of pure specimens. Hanbury & Flückiger relate that a large quantity was met with in the London market in 1878, and was being offered for cleaning polished metallic surfaces. **Adulteration.**

The substances found in the commercial article are the broken integuments of the capsules, portions of stalk, withered flowers, leaves, insects, dust and dirt. Atkinson (*Himalayan Districts*, 776) says the substances chiefly used to adulterate the powder are the pounded bark of **Casearea tomentosa** (*chila* of Garhwal), and a powder prepared from the red fruit of the Banyan trees (**Ficus bengalensis**). In Calcutta the powder is adulterated with sand, and in the United Provinces, with flour, sand and red earth. Professor H. G. Greenish in 1893 examined a false kamala from Bombay and found it to have been carelessly collected and mixed. One of the chief ingredients was badly preserved safflower (**Carthamus tinctorius**), besides other extraneous matter, and 16 per cent. of ash. **Adulterants.**

F. A. Flückiger (*Archiv. der Pharm.*, 1892·2) received from Dr. Greshoff, of Java, ripened capsules of the plant, which when air-dried weighed 207·1 grains. From these were obtained 12·74 grains of seeds, 22·66 grains of kamala (containing 3·92 per cent. of moisture), and 171·7 grains of capsule integuments; the kamala therefore amounted to 10·79 per cent., and was found to yield from 1·3 to 1·5 per cent. of ash. The integuments yielded on incineration 4·19 per cent. of ash, so an admixture of these would not account for the high percentage of ash in commercial kamala. The undesirable parts of the capsule can be so readily separated by sifting, that it is not possible to see how the "method of collecting" can increase the percentage of ash, unless the collector introduces some adulterating agent.

M. Caesar and M. Loretz (*Apoth. Zeitung*, 1891, 495) have sifted commercial kamala with the object of separating as far as possible the portions containing much mineral matter, of the specimens purified during the past two years, the best one gave percentage results as follows: 55 per cent. of worthless impurities as dirt, fruit and bark particles;

12, 10, 3·2 and 18 per cent. of purified kamala, containing 20, 16, 10, 7·5 and 6 per cent. of ash.

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Adulteration.

A sample recently submitted to the same treatment yielded 58 per cent. of worthless impurities; and

5, 10, 4, 8, 9 and 4 per cent. of purified kamala yielding 40, 35, 24, 21, 14 and 12·5 per cent. of ash.

Mr. Perkin's paper.

In 1899 the Reporter on Economic Products forwarded to the Imperial Institute selected samples of kamala received from the North-Western Provinces. The samples were sent through the Director, Professor Dunstan, to Mr. A. G. Perkin, F.R.S.E., of the Dyeing Department, Leeds, whose investigations in the chemistry of the dye have been so valuable. Mr. Perkin's, paper entitled the

Adulteration of the Indian Dye stuff, Kamala,

is reprinted from the *Journal of the Society of Chemical Industry*, 30 June 1900. No. 6, Vol. XIX.

"Kamala is the red mealy powder found on the surfaces of the trilobed capsules of the **Mallotus phillipinensis**, and is employed as a yellow dye stuff and for medicinal purposes. Its most important constituent is rottlerin, but in addition it contains insorottlerin, two resins, and a wax.

"Owing to the frequent adulteration which kamala undergoes in India, its examination in this respect was suggested to me by Prof. Dunstan, M.A., F.R.S., of the Imperial Institute, and four selected samples of the dyestuff were forwarded from India for this purpose. An accurate determination of the value of kamala by means of dye trials is not possible, owing to the incomplete exhaustion of the dye bath, and it is therefore necessary to estimate the ash, and more especially the constituents soluble in ether, for to these latter the tinctorial and medicinal effects of the drug are due.

"Anderson (*Edin. New Phil. Journ.* I. 300), who first examined kamala, states that his sample contained 3·49 per cent. of water, 78·19 per cent. of resinous matter, and 3·84 per cent. of ash, whereas Flückiger (*Archiv. der Pharm.* 1892), who examined a special sample from Java, found but 1·363—1·488 per cent. of ash. On the other hand, Seidler and Waage (*Ber Pharm. Ges. I. Berlin.* 1891, 80) found that the best kamala that could be procured by purchase in England, Germany, and North America contained at least 5 per cent. of ash, and frequently more. Instances of adulterated kamala have been previously mentioned (*Journ. Chem. Soc.* 1893, 63, 975), containing 52·5, 56·4, and 46·4 per cent. of ash, and some time ago, the writer received a sample of so-called kamala from Sir Thomas Wardle, of Leek, which consisted entirely of mineral matter.

"That various qualities are on the market is indicated by the following varieties which are offered for sale in a German catalogue,

Adulteration.

Mr. Perkin's paper.

viz.:—Kamala pura vera, 5 per cent. ash; Kamala, 3·5 per cent. ash; Kamala bidepurata, 10 per cent. ash; Kamala, 18, 25, and 35 per cent. ash, and kamala naturalis.

Analyses of the samples received are given below:—

(*a*) *Dye Powder, pure Bahraich, N.-W. P.*

	Per cent.
Soluble in ether	56·01
Organic soluble in water	7·65
Inorganic soluble in water	3·07
Woody fibre	21·30
Insoluble inorganic	11·90

(*b*) *Dye Powder, pure, freshly collected Gorakpur, N.-W. P.*

	Per cent.
Soluble in ether	51·67
Organic soluble in water	8·11
Inorganic soluble in water	2·51
Woody fibre	19·01
Insoluble inorganic	18·79

(*c*) *Dye Powder, Bazar, ordinary sample, Bahraich, N.-W. P.*

	Per cent.
Soluble in ether	39·16
Organic soluble in water	11·55
Woody fibre	21·84
Inorganic matter	27·45

(*d*) *Dye Powder, locally purchased, Gorakpur, N.-W. P.*

	Per cent.
Soluble in ether	7·71
Organic soluble in water	1·87
Woody fibre	3·42
Inorganic matter	·00

"Samples (*a*) and (*b*), though guaranteed free from adulteration, were evidently inferior in quality to the kamala examined by Anderson and Flückiger (*loc. cit.*). They contained fragments of capsules, seeds, and other vegetable extraneous matters, evidently derived from the Mallotus philippinensis itself. The impurity, being of a coarser nature than the kamala, could be removed to a large extent by sifting (through silk), and that the product was much improved thereby is shown by the following determinations:—

	(*a*)	(*b*)
	Per cent.	Per cent.
Ash before sifting	14·97	21·30
Ash after sifting	8·79	12·60
Ash in residue	23·71	30·47

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"The higher mineral content of (*b*) was partly due to its contamination with some particles of sand, evidently accidental, as the sample was of guaranteed purity.

"Sample (*c*) was duller in appearance than the "pure" samples (*a*) and (*b*). A considerable quantity of vegetable extraneous matter was present, evidently derived from the plant itself, and identical in character with that found in (*a*) and (*b*). By sifting, the following results were obtained :—

Ash before sifting.	Ash after sifting.	Ash in residue.
Per cent.	Per cent.	Per cent.
27·45	22·07	35·96

"The dull colour of the material suggested the presence of some special impurity. A quantity was suspended in water, the lighter portions decanted, and the residue treated several times in this manner. The residue so obtained consisted of brown-black earthy particles intermingled with sand in considerable amount.. From the quantity present it appeared that the material had been added for purposes of adulteration.

Earth and sand.

"Sample (*d*), as the analysis shows, contained but a trace of kamala, and was evidently highly adulterated. By agitation with water, a heavy residue separated, consisting entirely of mineral matter, which had a dull brick-red colour, somewhat resembling kamala, but not so bright. Examination showed that this was not a natural mineral earth, but a baked material identical in properties with *ground red brick.*

Brick dust.

"Beyond an admixture of vegetable matter derived from the plant itself, due to careless collection or wilful addition, the adulterants of kamala are thus of a mineral character. This fact was corroborated in each case by microscopical examination. The most serious adulterant is the powdered brick above referred to and this is most commonly employed owing to its resemblance to kamala itself. The samples of kamala mentioned above as containing 52·5, 56·4, and 46·4 per cent. of ash were all contaminated with a similar material, referred to at the time (*loc. cit.*) as a red ferruginous earth, but which was not then closely examined. Though inquiries were then instituted, and numerous samples tested, it did not appear possible to purchase in England a kamala which was not adulterated in this manner. The "Kamala naturalis" of the German catalogues is suggestive, and it is probable that only crude or adulterated kamalas are exported from

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Mr. Perkin's paper.

India, and that these are refined on the Continent by the merchants themselves.

"As a dye stuff its reputation is but local, and in this country its employment as a drug has been almost discontinued. In Germany, however, its medicinal properties are still recognised, and its disuse here may be due to adulteration, and a consequent lack of uniformity in the imported material."

Samples in Indian Museum.

As a supplement to the investigations made in England and on the Continent with reference to the amount of ash in the commercial glands of **Mallotus philippinensis**, the following figures are given to show the amount of ash in twenty-two samples exhibited in the Indian Museum, Calcutta.

Nilgiri Hills	2·8	Nepal	25·8
Cuttack	8·3	Cawnpore	42·8
Madras	11·2	Midnapore	11·1
„	4·6	Dehra Dun	3·4
Murshidabad	28·5	Saharanpur	61·6
Medical Store, Calcutta	18·3	Gorakhpur (forest)	19·7
„ „ Mian Mir	6·2	„ (bazar)	87·3
Puri (forest)	15·1	Bahraich (forest)	12·4
„ (forest)	33·1	„ (bazar)	29·4
Kheri (forest)	5·8	Tinnevelly (new)	4·1
„ (bazar)	15·5	„ (old)	28·1

These results show that kamala collected under personal supervision, as samples from the Nilgiri Hills and Dehra Dun, or derived direct from the forest, are eminently superior to supplies purchased in the bazars.

Benefit of sifting.

Experiments showed that on passing certain of the forest samples through a fine sieve of 100 meshes to a linear inch, most of the impurities consisting of broken vegetable organs and small grit were removed. Mere sifting, however, was insufficient to remove the fine red earth or ochreous clay that had found its way into the bazar samples.

Bartolotti has found the ash of kamala to contain a considerable quantity of manganese, and it has been suggested that this fact might be made the basis of a chemical process for discriminating between the pure and adulterated dyestuff. This suggestion was borne in mind when determining the amount of mineral matter in the above samples. Each sample of ash was tested separately for manganese, and it was shown that in the Bahraich, Kheri, and Tinnevelly powders this mineral was more in evidence in the impure than in the pure specimens.

Pharmacopœa standards.

The *British Pharmacopœa* of 1885 prescribes that kamala on ignition in air " should yield four or five, or at most ten, per cent. of ash." The *United States Pharmacopœa* placed the maximum limit

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Adulteration.

at eight per cent. For dyeing purposes the powder should not exceed ten per cent. of ash, and anything beyond this amount should be considered unsuitable. For medicinal purposes the powder should be of the utmost purity, and its frequent admixture with foreign matters has probably lowered its reputation in medical circles.

Dyeing.

Dyeing.

In India

The process of dyeing in Belgaum is as follows: 2lbs of silk and 1lb carbonate of soda are placed in a vessel of water and boiled for a short time. As soon as the silk softens it is removed. In the same water are then placed 20 tolas of kamala powder, 2½ tolas of jinjelli oil, ½lb. of the alum, 1lb. of carbonate of soda (in addition to the 1lb. previously used). This mixture is boiled for quarter of an hour and then the silk is replaced in the vessel and taken out after another quarter of an hour's boiling. The colour is deep yellow.

At Kollegal fullers earth and lime are used to soak the silk before dyeing. The jinjelli oil is added to prevent the liquor from frothing over when boiling.

In Burma the material to be dyed is first washed with water in which ashes have been boiled. This is to remove any grease in the material. The kamala is then added and the material is boiled until it is of the desired tint. When this stage has been reached, a little lime juice and alum are added to fix the dye. This gives a yellow colour. To obtain a red dye, when the above process is finished, the material is soaked in water in which lac has previously been boiled.

In the Yaw Division of Burma the ashes of the plantain tree are employed as a mordant in the dye bath.

Technical experiments in England.

Messrs. Hummel and Perkin (*Imperial Institute Journal, March 1897*), find that using a dyebath without addition sodium carbonate, a very feeble yellow was obtained on silk, but on addition of sodium carbonate a full bright orange is readily obtained if the operation be not prolonged; long boiling destroys the rottlerin.

The best results were obtained by adding to boiling water one part of kamala, and half to one part of sodium carbonate, then introducing the fabric and dyeing at the boiling point for from two to five minutes. The bath, of course, is not exhausted by such a rapid dyeing process. Other experiments showed that the proportion of sodium carbonate should be from thirteen to fourteen grains per litre of water. After dyeing for a short time with alkali only, the addition of alum or stannous chloride to the dyebath makes the colour a deeper and fuller orange.

In none of their dyeing experiments were Hummel and Perkin able to obtain the red orange shades of native kamala dyed silk;

M. 71-86.

these, they think, are produced by addition of other dyes, since when spotted with strong sulphuric acid they give a different colouration from that given by fabrics dyed with kamala alone. Dyeing.

The authors remark that the colours given by kamala on silk are fugitive to light, and since there are many artificial orange and yellow dyes now in use which are as easy of application and give much faster colours, it is out of the question that kamala can become a dye stuff of any value in European commerce. Conclusions.

In 1895 A. G. Perkin contributed to the Chemical Society the following note on "A Dyeing Property of Rottlerin." "The method of dyeing with kamala is not well understood, and is certainly rather remarkable, for, as previously shown, the various constituents it contains are insoluble in water. It is not intended to enter into the details of the process here, but the method essentially consists in boiling the material (chiefly silk) with kamala suspended in sodium carbonate solution. It is probable that in the process rottlerin plays the chief, if not the only, part, and the result obtained is due, not to the fixing of rottlerin on the material, but of the decomposition products produced by the action of the sodium carbonate, one of which, as shown above, is rottlerone. Even if the material be previously mordanted, no compound of rottlerin can be fixed in the fibre, because, as already stated, the alumina and iron compounds of rottlerin are decomposed by boiling sodium carbonate solution. Though of no practical value, it appeared interesting to test the behaviour of sodium and potassium rottlerin towards mordanted calico. For this purpose, they were suspended in water, dissolved by the addition of a little alcohol, the mordanted calico entered, and the whole brought to the boil. As was expected, the material was found to be dyed, yielding the following somewhat poor shades; iron mordant, brownish-black; alumina, pale orange-red; and mixed alumina and iron, orange-brown." Chemical results.

Other uses of kamala.

Other uses.

The red powder is said to be used by Hindu peasants in the Central Provinces for decorating their faces. In Berar it was formerly used by women of the lower classes in the place of *shendur* to mark their foreheads but other pigments are now applied to this purpose. In 1894 the powder was supplied to the Meerut Soap Company to be employed as a colouring material for soap, but the Manager reported as a result of the experiments that in combination with other substances the powder yielded only a pale yellow or orange dye and that of a dirty hew which was not permanent.

Timber.—Gamble remarks "The wood is of little use as timber, but is a useful fuel." The weight of a cubic foot ranges between Timber.

Timber.

41 and 51 pounds. It is reported to be used for fuel in Assam, Central Provinces (Jubbalpur), Bombay and Tinnevelly. The length of the bole is insufficient to permit of utilisation as squared timber even if desired. Its uses in the United Provinces are for temporary thatched buildings and for axe handles. In the Panjab the timber is known to be eaten by white-ants, and is only used for roofing poles when no other material is available. In Kangra the timber is sometimes used for rafters, and in Coimbatore the posts for house building are sometimes prepared from the tree. The cartmen and bullock-drivers of Kolaba, Bombay, employ *shendri* shoots for their driving sticks. They say that the wood is not too hard, and the sticks do not split up, and they last a long time.

Seeds.

Seeds.—The seeds, of which three are contained in each capsule, are black or dark grey, rounded, and slightly flattened on one side. They are about the size of black pepper. Their resemblance to the fruits of **Embelia Ribes** has been observed in the Panjab where the confusion of the names—*baobrang* for **Mallotus** and *bebrang* for **Embelia**—has existed. In Katha, Burma, the seeds ground to a paste are applied to wounds and *dah* cuts.

Greshoff, in 1898, discovered in the seeds a bitter glucoside soluble in water and alcohol, that may be shaken out of a water extract by chloroform.

The seeds analysed in the Indian Museum afforded:—Moisture, 8·75; fat, 5·85; albuminoids, 16·81; carbohydrates, 47·49; fibre, 17·35; ash, 3·75. They are, therefore, not oil-yielding seeds as has been reported.

Bark.

Bark.—The bark has been reported to be used in the United Provinces for tanning leather. **Professor Hummel** found 6·5 per cent. of tannin in the dry, powdered bark indicating an inferior material.

During some recent experiments in Rangoon, Burma, the bark of an undetermined species of **Mallotus** has been found to produce a most satisfactory tanning extract.

G. I. C. P. O.—No. 1526 R. E. P.—3-10-1905.—2,500—B. N. D.

(Vegetable Product Series, No. 92.)

THE AGRICULTURAL LEDGER.

1905—No. 5.

TARAKTOGENOS KURZII.

(CHAULMUGRA.)

[*Dictionary of Economic Products, Vol. IV.*, G. 381-388.]

Chaulmugra seeds of commerce,

by

David Hooper, F.C.S., F.L.S.

Taraktogenos Kurzii, *King, in Journal Asiatic Society Bengal, LIX. Pt. II. (1890), 121.* TARAKTOGENOS KURZII.

Syn.—Hydnocarpus heterophyllus, *Kurz.*

Vern.—*Chaulmugra, chaulmoogra,* Beng., Hindi; *Kalaw-bin* (the tree), *kalawthee, kalaw-thi* (the seeds), Burm. *Toung pung,* Arakanese.

Habitat.—A large tree 40 to 50 feet high found in the following districts:—Eastern-Bengal and Assam: Chittagong, Tippera; South Sylhet; Lushai Hills. Burma: Arakan Yomas, Mandalay, Pyinmana, Tharawadi, Hanthawadi, Shwegyin, Pegu, Amherst, Mergui; and in the Andaman Islands. Habitat.

History.—It seems that the inhabitants of South-Eastern Asia have for a long time been in the habit of using the seeds of this and of one or more allied species as a remedy for leprosy. Dr. Dymock states that in the *Makhyan-et-Adwiya* there is a short notice of the seeds under the name of *Chawul mungri,* and that their use in leprosy and other skin diseases is mentioned both as an internal and external remedy. Dr. William Roxburgh in 1815 defined the origin of the seeds as **Chaulmoogra odorata**, and in 1819 R. Brown described the plant under the name of **Gynocardia odorata**. In the *Bengal Dispensatory* published in 1842, the tree, under the former THE IDENTIFICATION OF THE BAZAAR SEEDS. A. D. 1815.

TARAKTOGENOS Kurzii. **Chaulmugra seeds of commerce.**

IDENTIFICATION OF THE BAZAAR SEEDS.

name, is said to be a native of Sylhet, and the seeds and oil were employed extensively in the treatment of cutaneous affections. In the *Indian Annals of Medical Science*, April 1856, it was brought to notice as a remedy for secondary syphilis. It was first given as a remedy for phthisis and scrofula by Dr. R. Jones, of Calcutta, in doses of six grains three times a day. In 1868, it was made official in the *Pharmacopœia of India*, where an ointment is directed to be made from the pounded kernels mixed with simple ointment. In that work it is recommended as an alternative tonic in cases of leprosy, scrofula, other skin diseases and rheumatism, in doses of six grains of the powdered seed in pill three times a day, to be gradually increased till nausea is produced, or five or six drops of the oil, similarly increasing the quantity. The oil appears to have been first used experimentally in England in the seventies. Of late years the knowledge and use of the drug have spread to Europe and America, where it appears to be increasing in favour and reputation.

Chaulmugra oil is officially recognised in the Indian and Colonial Addendum to the *British Pharmacopœia*, Government of India edition, 1901.

A. D. 1899.

The identification of the true botanical source of the chaulmugra seed of commerce originated with a French pharmacist, M. G. Desprez. During the year 1899 this gentleman made the discovery that the seeds received in Europe did not belong to **Gynocardia odorata** which for nearly one hundred years had been recognised as the source. This fact was communicated to Lieutenant-Colonel D. Prain, the Director of the Botanical Survey of India, who about the same time had found that the seeds sold in the Calcutta bazars are not those of a **Gynocardia**. But M. Desprez, not going quite so far in his analysis and still considering them to belong to that genus, provisionally named the source **Gynocardia Prainii.** Colonel Prain applied to the Reporter on Economic Products for information on the subject, and that officer instituted an enquiry in 1900, in Chittagong, Assam and Burma, requesting botanical specimens of the trees yielding the commercial seeds. Numerous samples were received, and in April 1901, Colonel Prain, on being supplied with material, recognised the plant as **Taraktogenos Kurzii**, a species described by Sir George King in 1890. Both trees grow in Chittagong and Sylhet; but while the **Gynocardia** is found in Sikkim and the Brahmaputra valley in Assam, **Taraktogenos** is widely distributed in Burma. As Colonel Prain points out the name **Chaulmoogra odorata** has priority over the name **Gynocardia odorata**, and is therefore the correct one to give to the tree which is the origin of the false Chaulmugra seeds.

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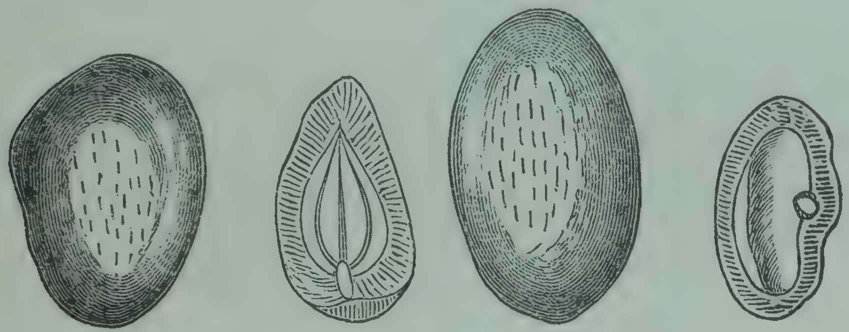
DISTINCTION OF TARAKTOGENOS AND CHAULMUGRA.

The inflorescence of the two trees may be easily distinguished. **Taraktogenos** has free sepals, small petals and flowers; **Chaulmoogra odorata** possesses connate sepals in a valvately, toothed or irregularly bursting cup, petals rather large and flowers comparatively conspicuous.



Taraktogenos (True chaulmugra) Chaulmoogra odorata.

The above figures illustrate the characters of the seeds. **Taraktogenos Kurzii** seeds have a thick, firm testa; albumen copious, firm; embryo central, straight, with large, cordate, foliaceous, 3-nerved cotyledons, **Chaulmoogra odorata** seeds are obovoid, imbedded in pulp, with large, tough, thick testa; albumen oily; cotyledons large, flat, fleshy, reniform, usually more or less eccentric, with radicle usually horizontal.

A description, with illustrations, of the microscopic structure of Chaulmugra seed, by **Dr. Joseph Moeller** of Vienna, appears in *Pharmaceutical Journal* [series 3] XV. (1884), 321.

CHEMICAL COMPOSITION.

Chemical Composition.—An exhaustive analysis of the oil was made by **Mr. John Moss** in 1879, and the result was communicated to the British Pharmaceutical Conference at Sheffield (see *Year-Book of Pharmacy*, 1879, 523-533.) The oil was shown to have a decidedly acid reaction, a melting point of 42° C., and to contain the following constituents: gynocardic acid 11·7, palmitic acid 63, hypogæic acid 4, and cocinic acid 2·3 per cent. These acids exist in combination with glycerol (or glycerine) as fats, and the two former in the free state as well. The acrid burning taste of the oil is said to be due to the first mentioned acid, the probable formula of which is $C_{14}H_{24}O_2$, with a melting point of 85° F. (29·5° C). Analysis by Moss.

A proximate analysis of chaulmugra seed was made by **E. Heckel** and **F. Schlagdenhauffen** in 1885 (*Journal de Pharmacie et de Chimie*, April 1st, 1885.) The fatty matter soluble in petroleum ether amounted to 30·12 per cent., albuminoids 24·2, and fixed salts 4·93 per cent. By Heckel and Schlagdenhauffen.

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TARAKTOGENOS Kurzii. **Chaulmugra seeds of commerce.**

CHEMICAL COMPOSITION.

By Petit.

A. Petit of Paris, in 1893, published a process for the preparation of gynocardic acid. (*Journal de Pharmacie et de Chimie*, in *Year-Book of Pharmacy*, 1894, 66). This consisted in saponifying chaulmugra oil with a solution of caustic soda, decomposing the resulting soap with sulphuric acid, and crystallising the fatty acids in 60 per cent. alcohol.

According to A. H. Allen (quoted by T. E. Thorpe, *Dictionary of Applied Chemistry*, iii. 43) the fat contains umbellulic acid. This acid is said to occur not only in chaulmugra oil but also in the fat of the Californian Bay tree. The formula for umbellulic acid is $C_{14} H_{22} O_2$, melting point 28·5, and boiling point under pressure of 100 mm. 212·°5.

Schindelmeiser's analysis.

In 1904 J. Schindelmeiser described chaulmugra oil obtained by cold expression from the seeds as a firm, yellowish mass, throughout which crystalline fatty bodies are distributed. It melted at 26°C., and remained fluid at 20° for about 15 minutes. It is soluble in a large quantity of alcohol and forms turbid solutions with absolute ether, chloroform, tetrachlormethane, carbon bisulphide, petroleum ether and ligroin, small flakes separating from the last two solvents after a short time. Its acid number was 25·04, saponification number 232·42, iodine number 92·45. A 35·71 per cent. solution of the oil in petroleum ether showed a rotation of $[a]_D$ 20°+10°28′. The acetyl number of the fatty acids was 207·8, and the iodine number 110·8. The author's investigations, furthermore, shows that gynocardic acid is a member of the fatty acid series, $C_n H_{2n-2} O_2$, and that it probably has the formula $C_{21} H_{40} O_2$ [*Apotheker Zeitung* 19 No. 36 (May 4, 1904), 306].

Power and Gornall's analysis.

The following abstract of a paper* on "The constituents of chaulmugra seeds," by Frederick Belding Power and Frank Howorth Gornall gives the latest and most valuable results of the investigation of these seeds. The authors state that Chaulmugra had previously been examined by Moss (*Year-Book of Pharmacy*, 1879, 523-533), Petit (*Journal de Pharmacie et de Chimie*, 1892, 26, 445), and more recently by Schindelmeiser (*Berichte der deutsche pharmaceutische Gesellschaft* 1904, 14, 164), but their results differ in many respects from those obtained by the present authors, which are as follows:—

An enzyme present.

The seeds of **Taraktogenos Kurzii**, *King*, contain a hydrolytic enzyme, and also an unstable compound, which reacts with the enzyme, when the seeds are crushed, giving rise to hydrogen cyanide. Numerous attempts were made to isolate this compound but without success. Further experiments will be made in this direction.

* From *Proceedings of the Chemical Society*, Vol. 20, 1904, 135-137.

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On expression, the seeds yielded 30·9 per cent. of a fatty oil, which had the following constants: m. p. 22-23°: sp. gr. 0·951 at 25° and 0·940 at 45°; $(a)^{15°}_{D} + 52°$; acid value 23·9; saponification value 213; iodine value 103·2.

On hydrolysis, the fatty oil yielded glycerol, a very small amount of phytosterol. $C_{26} H_{43} OH$ (m. p. 132°), and a mixture of fatty acids (m. p. 44-45°; $(a)_D + 52·6°$ in chloroform; acid value 215; iodine value 103·2), which consisted chiefly of several homologous acids belonging to a series $C_n H_{2n-4} O_2$ containing a closed ring and ethylenic linking, no member of which has hitherto been isolated from a fatty oil. The highest of these homologues present, which was isolated in a pure condition, separated from most of the usual organic solvents in glistening leaflets (m. p. 68°; b. p. 247—248° 20 mm., $[a]_D -59°$), has the formula $C_{18}H_{32}O_2$, and is designated chaulmoogric acid. It combines with only two atomic proportions of bromine or iodine. Palmitic acid also was identified, and there is reason for assuming the presence of a near homologue or homologues of chaulmoogric acid, but belonging to the series having the general formula $C_n H_{2n-4}O_2$ with two ethylenic linkings. Undecylic acid and hydroxy-acids were proved to be absent, and, an individual acid corresponding with hypogæic acid could not be isolated. The "gynocardic acid" of all previous investigators is believed to be a mixture of several substances.

Power and Gornall's analysis.

The "press-cake" yielded, besides formic and acetic acids and a very small amount of volatile esters having the characteristic odour of the seeds, an appreciable amount of a neutral oily substance, $C_{18}H_{32}O_2$, (b. p. 214-215°/18 mm., sp. gr., 0·9066 at 16°/16°, $[a]_D -42·4°$), which is isomeric with chaulmoogric acid; this substance is being further investigated, as are also the seeds of **Gynocardia odorata**.

The "press-cake."

A second paper by the above authors deals with the constitution of chaulmoogric acid.

The constitution of chaulmoogric acid.

With the object of ultimately determining the constitution of chaulmoogric acid, $C_{18}H_{32}O_2$, a number of its derivatives have been prepared and studied.

Methyl chaulmoograte, $C_{17}H_{31}·CO_2Me$ (m. p. 22°, b. p. 227° corr. /20 mm., sp. gr. 0·9119 at 25°/25°, $[a]^{15°}_{D} + 50°$ in chloroform), was prepared by the interaction of the acid, methyl alcohol, and hydrogen chloride. Ethyl chaulmoograte, $C_{17}H_{31}·CO_2Et$, a colourless oil (b. p. 230° corr./20 mm., sp. gr. 0·9079 at 15°/16°, $[a]^{20°}_{D} + 50·7°$), was prepared in like manner. Chaulmoogramide, $C_{17}H_{31}·CO\text{-}NH_2$ (m. p. 106°, $[a]^{27°}_{D} + 57·30$ in chloroform), was obtained according to **Aschan's** method (*Ber.*, 1898, 31, 2344). Bromodihy-

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CHEMICAL COMPOSITION.

drochaulmoogric acid, $C_{17}H_{32}Br{\cdot}CO_2H$ (m. p. 36—38°; optically inactive), is formed when chaulmoogric acid is treated with hydrogen bromide in glacial acetic acid.

Ethyl chaulmoograte absorbs two atomic proportions of bromine in the cold, forming ethyl dibromodihydrochaulmoograte, $C_{17}H_{31}Br_2{\cdot}CO_2Et$, which is an oil.

When chaulmoogric acid is treated with sodium in boiling amyl alcohol, the ethylenic linking is not resolved, but there were obtained, after fractional distillation of the product, chaulmoogryl alcohol, $C_{18}H_{33}{\cdot}OH$ (m. p. 36°, $[\alpha]_D$ +58·4°) and chaulmoogryl chaulmoograte, $C_{17}H_{31}{\cdot}CO_2{\cdot}C_{18}H_{33}$ (m. p. 42°), together with unchanged chaulmoogric acid.

The saturated acid, dihydrochaulmoogric acid, $C_{17}H_{33}{\cdot}CO_2H$ (m. p. 71—72°, b. p. 248°/20 mm.; optically inactive), is formed, however, on reducing bromodihydrochaulmoogric acid with zinc dust and alcohol, or chaulmoogric acid with hydriodic acid and phosphorus. By the latter process, a hydrocarbon, chaulmoogrene, $C_{18}H_{34}$ (b. p. 193—194°/20 mm.) is also formed. Methyl dihydrochaulmoograte, $C_{17}H_{33}{\cdot}CO_2Me$ (m. p. 26—27°, b. p. 222—223°/20 mm.), was prepared from the corresponding acid.

Chaulmoogric acid is not attacked by fused caustic alkalis even at 300°.

When chaulmoogric acid was oxidised with cold permanganate (1 atom oxygen), dihydroxydihydrochaulmoogric acid, $C_{17}H_{31}(OH)_2{\cdot}CO_2H$ (m. p. 102°), was produced, but when the amount of permanganate was equivalent to 4—5 atomic proportions of oxygen, formic acid and two dibasic acids were obtained, the latter having the formulæ $C_{15}H_{28}(CO_2H)_2$ and $C_{15}H_{28}O(CO_2H)_2$ (m. p. 128°). The ethyl esters of these acids were described.

The molecular magnetic rotation of ethyl chaulmoograte very closely approximates to the calculated value for an unsaturated ester of the formula $C_{20}H_{36}O_2$, having a closed ring and one ethylenic linking, the latter being contained in an allyl group. This conclusion, based on the magnetic rotation, is in harmony with the results obtained by the oxidation of the acid.

The further investigation of chaulmoogric acid is proceeding.

COMMERCIAL OILS.

Commercial Samples of the Oil.

Dr. W. Dymock in 1876 (*Pharmaceutical Journal* [series 3], 6, 761) drew attention to the difficulty that was experienced in distinguishing between the genuine oil from mixtures sold by the native druggists. A standard sample of oil was made by cold expression from carefully picked seed. This was of a pale sherry colour, threw

COMMERCIAL OILS.

down a granular white fat on standing, and the specific gravity was 0·90. A test for the oil was thus utilised. Twenty drops were placed in a watch-glass and one drop of strong sulphuric acid was added; on stirring with a glass rod, a mass of a reddish-brown colour was formed which in the course of a few minutes turned of a rich olive green. Out of five samples tested, only one was genuine, the remaining were supposed to be adulterated with sesame oil, solid fat and nut oil.

It has since been pointed out that the green coloration is not peculiar to the oil but is a property which equally belongs to palm oil.

Hirschohn's researches.

Having observed differences in the behaviour of two samples of chaulmugra oil to solvents, Dr. Ed. Hirschohn procured at different times some additional commercial samples and subjected them to comparative examination with three samples prepared direct from the commercial seeds, No. 1, prepared by cold expression; No. 2 expressed warm; No. 3 extracted with petroleum ether. These oils when first prepared were perfectly clear, but in a short time became turbid and granular in consistence. The odour was the same as that of the commercial oils. The yield calculated for the original seed, amounted to 40·25 per cent., and amounted to 62 per cent. of the decorticated seeds used. The melting points of these pure oils varied between 26° and 28° C., while those of the commercial samples designated as A, and C and D ranged from 28° to 30°, the fourth sample B melting, however, at 50° C. The author describes the solubilities of these oils and tabulates the constants, obtained by the usual methods, as follows:—

Sample.	Acid number.	Saponification number.	Iodine number.
No. 1, cold pressed . .	26·84	205·55	99·5
No. 2, warm pressed . .	25·54	210·07	96·8
No. 3, p-ether extract . .	21·14	198·88	98·3
A. commercial oil . .	87·33	253·07	69·7
B. " " . .	34·44	95·60	33·9
C. " " . .	70·66	207·14	88·0
D. " " . .	37·60	198·40	96·4

[*Pharmaceutisches Centralblatt*, 44, No. 38 (Sept. 17, 1903), 627.]

The oil-cake as a manure.

OIL-CAKE.

Last year a Calcutta firm forwarded a sample of chaulmugra oil-cake to the Reporter on Economic Products for valuation as a manure. The sample was sent to the Inspector General of Agriculture

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OIL-CAKE.

who obtained the following analysis and report made by Dr. J. Walter Leather, Agricultural Chemist to the Government of India :—

Moisture	7·14
Organic matter	83·42
Soluble ash	7·89
Sand	1·55
	100·00
Nitrogen	3·39
Phosphoric acid	1·80
Potash	1·55

This cake contains half as much nitrogen as good castor cake, and about three-fourths as much as rape and mustard cakes contain. Of phosphoric acid it contains also less than those cakes usually contain and less potash than is often found. In placing a value on this material in comparison with other manure cakes it must be remembered that its nitrogen is very much the most important constituent for most lands. If phosphates were wanted, other materials would be purchased. Its market value must also depend very much on the local supply of other materials.

TRADE.

Trade.

Chaulmugra seeds are brought to Calcutta chiefly from Chittagong and as sold in the market are of two kinds, *viz.*, (1) mature seeds with a brown kernel rich in oil ; (2) immature seeds with a black kernel, containing a smaller proportion of oil of a dirty colour. The seeds arrive in the market at the end of the rainy season, in November and December. Mr. E. P. Stebbing, Deputy Conservator of Forests, Chittagong, informed the Reporter on Economic Products that chaulmugra seed comes from the Kassalong Reserve in the Chittagong Hill Tracts where it is plentiful; and is exported from the Reserve down the Kassalong river into the Karnafuli river and down the latter to Chittagong. The tree is said to be scarce in the unclassed forests of the Hill Tracts. From 1,200 to 1,500 maunds of seed are annually exported from the Hill Tracts to the collectorate, *viâ* the Karnafuli river alone. About 50 maunds of the seed were exported from the Kassalong Reserve during the year 1899-1900 at R1 per maund. There is no check on the export from the reserved forests of the Hill Tracts, as at present no Government tax is levied on it. The seeds are brought out of the forests by Jumchas and are sold by them to the Bengalis at Kassalong.

Chittagong Forests.

Price.

Chaulmugra seed formerly sold in Calcutta at R5 to R7 per maund of 82 2/7 pounds. In 1893 the supply in the market was small and the seeds were selling for R13 per maund.

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Trade.

Occasionally the seeds are sold by public auction in Calcutta. In July 1900, 18 bags were put up for sale, weighing, approximately, 21 maunds. That year the price rose from R12 and R15 to R29 and R30 per maund. The trade is confined to a few Bengali traders, and the quantity disposed of yearly is about 5,000 maunds.

At present the price of the seed is R3 to R4 per maund at Chittagong and Sylhet, and the Calcutta price R6-9 per maund.

Chaulmugra seeds are collected for sale in Burma, but statistics are not available as to the extent of the exports. In the forest administration reports of ten and eleven years ago Kalawe (Calaway) fruits and leaves are shown to be exported from Mergui to provincial ports.

Extraction of oil.

To extract the oil from chaulmugra seeds the kernels are separated from the shells and dried in the sun. They are then partially pounded with a pestle and mortar such as is used for husking rice and pulses. The broken kernels are then put into canvas pads, and the oil is expressed with the aid of fire in a castor-oil mill. Sometimes the oil is expressed in a native oil-mill, but this method is attended with waste of oil in the refuse. As a rule the oil is not refined. There are two kinds of oil known, *viz.*, (1), clear, bright, straw coloured (2) muddy and precipitating a sediment of earthy colour.

Calcutta.

One maund of oil is obtained from about four or five maunds of seed. The price of the oil is R60 per maund.

Messrs. Butto Kristo Pal & Co. and Messrs. Daw Brothers, Old China Bazar Street, are the principal dealers in Calcutta.

Bombay.

Dr. Dymock writing in 1890 in regard to the Bombay trade says, "the seeds come from Calcutta and cost in Bombay about R15 per Bengal maund." The oil has been expressed at the Bombay Medical Store Depôt for many years past and issued for the treatment of leprosy. As the seed obtained locally is not always of good quality, it would appear desirable to obtain a constant supply of good fresh seed from Calcutta.

Madras.

The oil is used in European hospitals in Madras and is chiefly supplied by a contractor who expresses the seeds imported from Calcutta. The rates tendered for the oil at the Medical Stores are 12 annas to R2-4 per lb. Moodeen Sheriff gives its price as R5 per lb. and 6 annas per oz. in the bazars.

False Chaulmugras.

FALSE CHAULMUGRAS.

Chaulmugra odorata, *Roxb.* (**Gynocardia odorata**, *R. Br.*) A native of Sikkim, Chittagong and Assam. The seeds of this plant have been described (see *ante*, p. 73).

An investigation of these seeds has recently been made by Dr. F. B. Power and Mr. T. H. Lees, [*Journal of the Chemical Society*,

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FALSE CHAULMUGRAS.

Chaulmugra odorata.

LXXXVII (April 1905), 349], who found in them a cyanogenetic glucoside which they succeeded in isolating, and designated gynocardin. The yield of this substance was equal to 5 per cent. of the weight of the seeds. Gynocardin melts at 162-163°, and has the formula $C_{13}H_{19}O_9N$. The enzyme of the seed, gynocardase, brought into contact with the aqueous solution of the glucoside, immediately evolves hydrogen cyanide or prussic acid.

Composition.

In a later paper (*Journal of the Chemical Society*, LXXXVII, June 1905, 896). Dr. Power and Mr. M. Barrowcliff recorded the separation and examination of the constituents of the seeds of **Gynocardia odorata.** The shells represented 37 per cent. of the weight of the seeds. The kernels, when subjected to hydraulic pressure, afforded an amount of fatty oil and of a "press-cake" equivalent, respectively, to 19·5 and 40 per cent. of the weight of the entire seed.

This oil is quite distinct from the chaulmugra oil of commerce, for whereas chaulmugra oil at the ordinary temperature is a solid (m. p. 20°—23°), the oil of the **Gynocardia** seeds is a liquid. Furthermore, chaulmugra oil is optically inactive and consists of the glyceryl esters of members of the chaulmoogric acid series, whereas the oil from **Gynocardia** seeds is optically inactive and contains neither chaulmugric acid nor its homologues.

The present investigation has shown that **Gynocardia** oil consists of the glyceryl esters of the following acids: (1) linoleic acid, or isomerides of the same series; constituting the largest proportion of the oil; (2) palmitic acid, in considerable amount; (3) linolenic and isolinolenic acids, the latter preponderating; and (4) oleic acid, in relatively small amount.

The expressed oil, and that extracted from the seeds by ether, gave the following values respectively:—

	Expressed Oil.	Oil extracted by ether.
Specific gravity . . .	0·925 at 25°	0·929 at 25°
Acid value	4·9	5°
Saponification value . .	197·0	199·6
Iodine value	152·8	152·0

Hydnocarpus Wightiana.

Hydnocarpus Wightiana, *Blume.*

A tree indigenous to the Western Peninsula of India, from South Concan to Travancore. The oil of the seeds has been brought to the notice of Europeans as a substitute for chaulmugra oil, and has been used in the Bombay Presidency with satisfactory results. The seeds are not an article of commerce. The seeds are described in *Pharmacographia Indica*, vol. 1, 148-9, and *Pharmaceutical Journal*, 1900, 64, 552.

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FALSE CHAULMUGRAS.

Composition.

Dr. Power and Mr. M. Barrowcliff have recently examined these seeds and the results are recorded in *Journal of the Chemical Society*, LXXXVII, (June 1905), 884-96. The kernels which represented 75 per cent. of the weight of the seeds, afforded, when subjected to hydraulic pressure, 32·4 per cent. of oil and 35·4 per cent. oil-cake. By completely extracting the seeds with ether, 41·2 per cent. of oil was obtained. The oil, like true chaulmugra oil, is, at the ordinary temperature, a soft solid having a faintly yellow colour and a characteristic odour. It gave the following values :—

	Expressed Oil.	Oil extracted by ether.
Melting point . . .	22—23°	22—23°
Specific gravity . .	0·958 at 25°	0·959 at 25°
$[\alpha]_D$ in chloroform . .	+57·7°	+56·2°
Acid value . . .	3·8	7·4
Saponification value . .	207·0	207·0
Iodine value . . .	101·3	102·5

The oil from these seeds closely resembles chaulmugra oil in physical characters and in their chemical composition. It contains chaulmoogric acid and a lower homologue of the same series. This new acid has the formula $C_{16}H_{28}O_2$, and melts at 60°, and it is designated hydnocarpic acid.

Hydnocarpus anthelmintica, *Pierre.*

Hydnocarpus anthelmintica.

A tree indigenous to Siam. The seeds are exported to China under the name of "*Lukrabo*," and are known in the latter country as "*Ta-fung-tsze.*" These seeds are described and figured by Hanbury, *Science Papers*, (1876) 244-245 ; see also *Pharmacographia Indica*, Vol. I, 146-148. *Pharmaceutical Journal*, 1900, 64, 522.

Composition of oil.

Dr Power and Mr. M. Barrowcliff investigated these seeds and the results are recorded in the above quoted paper communicated to the Chemical Society. The seeds were divested of their shells which represented 68·8 per cent. of their weight. The powdered seed, extracted with ether, afforded 17·6 per cent. of oil. The oil is nearly colourless, solid at the ordinary temperature and has the same characteristic odour of chaulmugra oil. Its values were determined with the following results :—

	Expressed Oil.	Oil extracted by ether.
Melting point . . .	24—25°	23 24°
Specific gravity . . .	0·953 at 25°	0·952 at 25°
$[\alpha]_D$ in chloroform . .	+52·5°	+51
Acid value . . .	7·5	8·1
Saponification value . .	212·0	208·0
Iodine value . . .	86·4	82·5

It contained chaulmugric and hydnocarpic acids and afforded indications of the presence of a cyanogenetic glucoside.

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1905—No. 6.

SORGHUM VULGARE, PERS.,

(ANDROPOGON, SORGHUM, BROT.)

[*Dictionary of Economic Products, Vol. VI., Pt. III., S. 2424-2500.*]

SORGHUM VULGARE, THE GREAT MILLET OR JUAR IN INDIA.

By SIR GEORGE WATT, KT. C.I.E.

SORGHUM HALEPENSE the wild ancestor.

The account may commence with a brief notice of **Sorghum halepense,** from which the cultivated **Sorghum vulgare,** is believed to have originated.

Sorghum halepense, *Pers., Synop. I.,* (*1805*) *p. 101;* HOLCUS HALEPENSIS, *Linn.;* ANDROPOGON HALEPENSIS, *Brot. Fl. Lusit. I.,* (*1804*) *p. 89;* A. SORGHUM, *subspec.* HALEPENSIS, *Hackel in DC. Monog. Phanerog. VI.,* (*1889*) *p. 501;* ANDROPOGON (SUBGEN. SORGHUM) HALEPENSIS, *Hooker f., Fl. Br. Ind. VII.* (*1897*), *182; Vasey, Agric. Grasses of the United States* (*1st Ed. 1884*), *p. 51; 2nd Ed. 1889, p. 36; Duthie, Fodder Grasses N. Ind.* (*1888*), *p. 404; Lisboa, List Bombay Grasses* (*1896*), *p. 74; Dict. Econ. Prod. VI., Pt. III., 280.* THE JOHNSON GRASS, CUBA GRASS, MEAN'S GRASS, FALSE GUINEA GRASS, EVERGREEN MILLET, ARABIAN MILLET, &c., and in India best known as *Barú, bara, barwa, barua, bowári, braham, kálá-mucha, galla-jári, padda-jallagadi, gadi-janu, kartál, bikhonda.* &c.—names that mostly denote an edible product. A tall perennial grass with strong creeping underground stems which throw up many suckers; common throughout India and Burma on both cultivated and uncultivated lands; indigenous both in India and Africa up to latitudes of 30° North. Some few years ago an effort was made to acclimatise freshly

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SORGHUM HALEPENSE the wild ancestor.

imported stock both from Australia and America. As is customary in such experiments it was at first greatly extolled as a valuable addition to the fodder plants (oblivious apparently of the fact that the self-same grass was an abundant wild plant in India), but in time it was condemned, owing to its deep-seated and vigorous root-stocks which were difficult to eradicate. Finally it was recorded that if left to itself the introduced plant was in a few years exterminated by the indigenous vegetation. (*See Experimental Farm Reports*: also *Reports of the Departments of Land Records and Agriculture from 1895-96 to 1901-02.*)

There are two forms met with in India which were by Roxburgh treated as separate species but which in the *Flora of British India* are exhibited thus:—

1. Var. GENUINUM, (**Andropogon miliaceus,** *Roxb.*). Lisboa mentions *narvas* and *bhonda* as vernacular names for this plant. Roxburgh tells us it was sent to him by General Martin who found it on the mountains to the North of Oudh.

2. Var. EFFUSUM, (*A. laxus, Roxb.* (*non Linn.*)); **A. halepensis,** (*Wight, Cat. n. 1672*). According to Roxburgh, this is the plant specially denoted by the names, *kálá-mucha, gadi-janu.* He tells us that it grows in hedges, on banks of water-courses and on land that has lately been cultivated.

In the paragraph devoted below to the history of **S. vulgare,** reference will be made to the value of this wild plant, admittedly the source (according to most authors) of at least one group of the cultivated grain-yielding forms of the genus. But in passing it may be suggested that the vernacular name *bikhonda,* which would appear to be given to **S. halepense** (in certain mountainous countries) may possibly be intended to denote its somewhat evil reputation. It would appear that the grass eaten by cattle, especially when it is very young or when stunted by drought or parched by growing on exposed dry rocky soils, has frequently poisonous after-effects. Stewart was, for example, told in Hazara that cattle after eating *baru* grass suffered from fatal head affections. In many parts of India it is believed to be injurious until after the rains. The grass, as a fodder plant, is not so highly valued therefore in India as it would appear to be in Australia and United States of America, in which countries it is regularly and extensively cultivated and is never known to become poisonous. It will be seen below that a similar poisonous property is sometimes acquired by the cultivated juar.

The grain is often systematically collected and eaten, though the plant seems nowhere to be specially cultivated. Hamilton, for example, speaks of a kind of bread being made from it in Rajmahal. Tod (*Rajasthan, II., 170*) mentions the seeds being collected and mixed with *bajra* and eaten by the poorer classes in Bikanir.

SORGHUM VULGARE.

S. vulgare, *Pers., Syn. I., 101;* HOLCUS SORGHUM, *Linn. Sp. Pl. 1047;* A. SORGHUM, *Brot., Fl. Lusit. I.* (*1804*), *88; Roxb. Fl. Ind.* (*1832*), *269;* A. SORGHUM, subsp. SATIVUS, *Hackel,* in

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NAMES.

DC. Monogr. Phanerog. vi (*1889*), *505*; *Hooker f., Fl. Br. Ind. VII.*, (*1897*), *183*; *Dict. Econ. Prod. VI., Pt. III.*, (*1893*), *289-317*. THE INDIAN OR GREAT MILLET; GUINEA CORN; TURKISH MILLET; SORGO; KAFFIR CORN; CONGO MILLET; JERUSALEM CORN; BROOM CORN; MILO MAIZE; &c. In the vernaculars of India it is the *juár* (*juári*), *joár, jowár, juvár, jvár, juvri, junál, jondla, jaundri, jondhala, jonna, janu, jonnalu, jolah, irungu, chola, cholam, talla, tella, konda, rataru, ratadiu, sundia, singhia, jeti, pairia, kurbi, challi, chari* (the stalks or fodder), *dhui* (the chaff), *chavela, kasa-jonar, vani, phag, thuthera, lani, ka, kar, kangra, karbi, kadbi* (the stalks), *kutar* (the chaff), *shalu, ganeri, dukria, kadval, sajja, kenjol, yengara, mri garuphongbol, pyaung, &c., &c.*

In India the Great Millet is sometimes contrasted with Maize and called the *choti-juár* (= small *juár*), just as in Europe in early times it was contrasted with the Roman **Zea (Triticum speltum)** and in Reunion to-day is the Kaffir Maize. Its Persian name *Juar-i-Hindi* points to its having reached that country from India, while its Afghan name (*Jowhri-Turkimani*) points to an interchange with Asia Minor. Though the word *Juar* appears and re-appears, time after time, in the languages and dialects of India cognate with Hindi and Sanskrit, practically every aboriginal tribe or distinctive people has a name of its own for this particular grain, for the plant as distinct from the grain, for the fodder and for the chaff, quite independent of the names given to the corresponding products of wheat, barley, or rice. There are, moreover, distinctive names for each and every one of the numerous cultivated forms of the plant which exist in the provinces of India. In Bombay Presidency alone, over 250 races of the plant are recognised. There are also many curious traditions and religious observances so intimately associated with the grain as to establish beyond cavil a cultivation of vast antiquity.

Varieties.

Although accepted by most botanists to have been derived from **S. halepense,** the Sorghum has been dispersed by cultivation to latitudes considerably to the North and South of its indigenous habitat. It is in fact cultivated in most countries between the latitudes of 45° North and 35° South. These are the extreme limits and it does not do well so far North as 45°. In the Trans-Caspian Province of Russia, for example, the roots are apt to be frosted, before the seed ripens. (*cf.* "*Industries of Russia*" (*1893*), *Vol. III., p. 455, trans. Crawford*). In India and Africa it is, however, of greatest value in the upland tracts (above inundation level) between the latitudes of 15° and 30° North. In warmer moister regions, as for example in Bengal, in large portions of Madras, in lower Burma,

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and in Ceylon it hardly ranks as an important cereal since in these regions the grain ripens but indifferently.

History.—According to Crooke (*Rural and Agric. Gloss. 1888, p. 139,* also his edition of *Hobson-Jobson* (*1903*), *p. 468*) the word *juár* has been derived from the Sanskrit *yava-parkára* or *akára,* which means "of the nature of barley." Dutt (*Mat. Med. Hind., p. 324*) mentions *yávanála* and *rakta-khurna* as its special Sanskrit names. From *yávanála* would, of course, come *jávanála, jauanála, jauanára,* and finally *juár.* The Arabic *Dúra* (or as it is variously written *dhurra, dhaura, douro, etc.*) readily becomes *zúra,* and has been sanskritised as *zúrna* and is thus but a variant of *júar.* It would seem probable that the earliest mention of the name *dura* (or *dorah*) occurs (9th century A.D.) in Avicenna's reference to the people of Zanzibar living very largely on the grain of that name. As showing the ease with which *juar* has passed into *dura* it may be mentioned that M. Henri Jumelle (*Cult. Colon. 1901, pp. 103-110*) renders the modern Hindustani *juar* as *djowar,* and the Telegu *jola* as *djoula.* The Javanese name for this grain is *djagomutri.* It is probably also the *tsjolam* of the Malabar (*see Rheede, Hort. Mal. XII., 113, t. 60*). It certainly is the *battari* of the Malays (*Rumphius, Herb. Amb. V., 194, t. 75*). According to some writers Sorghum may have been the *dokhan* mentioned in the Old Testament (*Ezekiel, chap. IV., verse 9*) though in modern Egyptian that name seems to denote *Setaria italica*—the *Panicum* of Pliny. The *Milium* of Pliny (*Hist. lib. XVIII, c. 7.*), which he tells us had been introduced into Italy from India, was doubtless however one of the numerous forms of Sorghum. In Holland's English translation of Pliny (published 1601 A.D.) a marginal note identifies it as "Turkish Millet," thus suggesting an introduction into Europe *viâ* Persia and Asia Minor. Hehn (*Kult.-Pfl. Ed. 6, 1894, p. 592, n. 97*) suggests that it does not follow that Pliny's plant actually came from India. The trade route being then *viâ* Alexandria it is probable he thinks that articles procured from Egypt may have come to be regarded as of Indian origin. De Candolle (*Or. Cult. Pl.*) regards Pliny's reference to an Indian Millet as denoting the variety *saccharatum* rather than the *Sorghum vulgare* proper, chiefly because of its being described as 7 feet in height. In India a height of even 12 to 15 feet would be nothing very extraordinary. Rauwolf (*Travels* (*1583*) *II. p. 198*) speaking of Babylonia says it was being harvested in October and that it had grown to 6 to 8 cubits in height, though his reference to the stems being chewn, like sugar-cane, suggests the plant having been one of the many forms of the variety *saccharatum.* It is called, he concludes, by its old Arabic name *dora* of which both Rhases and Serapion make special mention. Forskal (*Fl. Ægypt.-Arab.* (*Niebuhr Ed.*) *1775, 174-5*) says its Arabic name is *taam.* Schweinfurth (*Heart of Africa* (*1873*) *I., 245-6*) observes that in the Soudan it is called *aish* (= bread). It is the *sergada* in Abyssinia.

Origin of word Sorgh.

The origin of the name Sorghum or Sorgho might be expected to throw much light on the history of the crop. Rees (*Cyclopædia, Ed. 1819*) followed by Paxton, Johnson, and most botanical lexicographers, says it is an

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Oriental word and comes from the Indian *Sorghi*. This doubtless is a mistake since no such name for it exists in any Indian language. Koernicke & Werner (*Handbuch d. Getreide-baues* (*1885*) *I.*, *294-315*) seem to think that it came direct from the Arabic *dorah*. The initial letter they suppose on its passing westward became softened into "th" and ultimately into "s." Sadebeck (*Cult.-gew. d. deutsch. Kolonien*, (*1899*) *48-52*) and many other authors speak of it as the *sirch* of the Southern Tyrol. He adds that the *sirch*-brooms (often falsely spoken of in trade as rice-brooms) were formerly employed in paying tithes. Wiesner (*Rohst. d. Pfl.-Reiches* (*1903*) *II.*, *207*) calls them "rice-brooms." Most, writers on the agriculture of Southern Europe cite names for this plant which may or may not belong to the language used by the authors in question. These are:—*Milium indicum* or *saracenicum* or *sabaeum*, *Turcicum frumentum*, *melica*, *milica*, (Latin); *saggina*, (*saginor* = to swell up), *sorghum*, *sorgi*, *surga*, *melegua*, *sorgho*, &c. (Italian); *cirok*, *sirek*, *sirch*, *szjérak*, *tatarka*, (Magyar & Slav languages); *blé de Guineé*, *blé barbu*, *sorgho* (*imphy* and *à balais*), *couscou*, *millet-d'Afrique*, *&c.* (French); *boonvana*, *sagova*, *Milium saburrum*, (*sic ?*), (Spain); *Vuelchen* (*Welschen*) *Hirssen*, (N. Germany); *Sorgsamen* (Nuremberg); *Sorg-weizen*, *Supe*, (Upper Tyrol); *Honig-gras*, &c., (Germany); *Turcks-koren*, *sorgsaet* (Flanders and Belgium); *catambochio* (Epirus); *Turkie millet*, *kaffir-corn*, *negro-cane*, *bushel-maize*, &c., (English).

John Arduin in his notes on Pliny (l.c.) published 1723, observes that Scaliger (*Exercit.* (*1557*) *292*, *p. 869*) is responsible for the statement that his countrymen, the Italians, called it "*surgum*." Schweinfurth says that Petrus de Crescentiis, about the year 1300 A.D., was the first author who definitely alludes to Sorgo. However in the editions of his *Agricultura*, dated 1471, 1571, and 1553, *melica* (*milica*) and in Italian versions *sagina* occur, but not *sorgo*. Mathiolus (*In Dioscoridem* (*1565*) *II.*, *407-8*) while repeating Ruellius' statement (*De Nat. Stirp.* (*1537*), *p. 320*) that *Panicum* is called *Mellica* in Italy, affirms that the *Mellica* is the *saggina* of Etruria and the *sorgo* of the other parts of Italy. Porta (*Villa &c. 1592*, *p. 865*) accepting Pliny's statement that this millet came from India to Italy in the time of Nero, observes that it was called by the Italians *sagina*, *melica*, or *surga*. He then gives a derivation of the last name from "*surgo*-to rise" in allusion to its towering above all other crops. This is exactly the meaning of many of the Japanese and Chinese names for the crop. The Ethiopian *sorghum* to which Porta further on alludes, as more recently introduced into Italy, is doubtless one of the many white-grained forms, of which so much has been written by the 16th, 17th, and 18th century authors. Thus, for example, Bellonius (*Apud Clusium*, *Observ.* (*1605*) *II.*, *154*) speaks of the common people of Cilicia having to go so far for firewood that they had taken to the cultivation of a white-grained form of Sorgho, the stems of which they found excellent firewood. This particular plant, he adds, is known to the Arabs as *hareoman* [? misprint for *hartoman*—see *Dozy*, *Suppl. aux Dict. Arab*, *Vol. II.*, *p. 756*]. John Bauhin (*Hist. Pl.* (*1651*) *III.*, *448*) is doubtless alluding to the same plant when he speaks of

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the Ethiopian Millet being the *areoman* of Avicenna [who lived in the 10th century]. C. Bauhin (*Theat. Bot.* (*1658*) *I.*, *510*) mentions red, white and black forms of "*Sorgo,*" some being early and others late crops.

The name Sorghum originated in Europe.

Whether, therefore, we accept the derivation given by Kœrnicke or that given by Porta, it would seem that the word Sorghum, as it now exists, originated in Europe and is strictly speaking the name for the warm temperate grain-yielding races of the plant, the forms that correspond with the *rabi juár* of India presently to be described.

Early Indian travellers do not notice it.

Few, if any, of the European travellers in India, whose writings as a rule are so fruitful of historic evidence, make any reference to this grain. Marco Polo, for example, who conducted extensive explorations in 1290 A.D. through a large portion of Asia (where the plant doubtless was being cultivated) makes no reference to it. It is not mentioned by Vasco da Gama who visited Calicut in 1498, nor by Garcia de Orta, Linschoten, Bernier, nor Tavernier. Yet we can have little doubt that it was extensively cultivated in India during at least the period of the explorations indicated. In the Ain-i-Akbari—the Administration Report of the Emperor Akbar for the year 1590—its price is quoted in a list of autumn grains, and in a further passage (*Gladwin's transl. II.*, *62*) it is remarked that—"*Jewary* and *Bajera* are the grains chiefly cultivated in the Subah of Guzerat." So again speaking of Khandesh (*Jarrett's transl. II.*, *223*) we read "*Jowari* is chiefly cultivated, of which in some places there are three crops a year, and its stalk is so delicate and pleasant to the taste that it is regarded in the light of a fruit." It is, however, comparatively little grown on the Malabar Coast even to the present day, and was hardly likely, therefore, to have been seen by the traders and travellers who for the most part visited the coast towns. Kœrnicke, who maintains with De Candolle, that as a cultivated plant it originated in Africa, not India, observes that it probably reached Asia by sea and not by land routes, as was often the case. But if that were so, we might expect to find it most extensively cultivated near the coast, whereas when we first learn definitely about it in India it is the staple food of the people who occupy the interior and drier tablelands, not the warm moist regions near the sea. It is in fact met with approximately in regions where its presumed wild stock **Sorghum halepense** is most plentiful. It is very possibly on this account that the plant is only doubtfully accepted by botanists as being described by Rheede (*Hort. Mal.* (*1678*) *XII.*, *t. 60*), though a century later Rumphius (*Herb. Amb.* (*1750*) *V.*, *194 t. 75*) figures and describes the plant, calls it *hareoman* (? *hartoman*), and furnishes a review of some of the writings of the more important 16th-18th century authors. Rumphius adds, "sown nearly everywhere in India especially the black kind .... but not amongst rice where the soil is watery, for *Battari* loves dry soil."

Akbar refers to it, 1590 A.D.

Rumphius figures it, 1678 A.D.

The plant must have had an Indian origin.

It is perhaps hardly necessary to elaborate further this historic sketch. While some of the known cultivated races of Sorghum doubtless originated in Africa, Egypt, and even Europe, it is at least safe to affirm that India, quite independently, evolved many of its most prized forms of that crop, and there is every probability that it even gave these in

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exchange for a few of the races which appear to have been derived from foreign countries. It is fairly evident, then, that the philological and historic data reviewed by De Candolle do not justify the exclusion of India from the list of original contributors to the world's supply. Woenig (*Pflanzen im alten Ægypten, 1886, 171-74*) who paid special attention to the evidence of ancient cultivation in Egypt arrived at the opinion that in prehistoric times **Sorghum vulgare** had found its way from India to North Africa. It was there cultivated and gradually distributed southward until it reached Central Africa. He mentions a fresco depicting a harvest field on the walls of the grave of Amenembes in Beni Hassan, 2400 to 2200 B.C., which he has no hesitation in declaring to have been intended for *Durra*. The fact that Roxburgh and other Indian botanists speak of having seen forms of **S. vulgare** in a state of cultivation only is no argument against the Indian origin. No one in any part of the world has recorded the discovery of truly wild form. Its accepted wild prototype (**S. halepense**) is quite as plentiful in India as in Africa. Schmidt who speaks of having found Sorghum "completely naturalised" in the Island of San Antonio is most careful to explain that he regarded his material as unsatisfactory seeing that he found only leaves and that these had been determined by comparison with certain plants preserved in the University herbarium of Göttingen. If such a statement can be accepted as a justification for the opinion that the cultivation of the plant originated in Africa *and not in India*, then many similar passages might be quoted in support of India's claim. For example, Sir Walter Elliot, a botanist and linguist of no mean order, wrote (*Fl. Andh. 1859, p. 95*) that he had found a "? wild kind known as *konda-jonna*." In a further passage he remarks that the Tamil name for the plant *Cholam* was in all probability derived from the fact that it was the chief grain of ths *Chola* Country. It is quite customary in India for places to be named after abundant or characteristic plants—witness Almora (the country of **Rumex hastatus**). It is significant also that the grain of the wild **S. halepense** (especially one particular variety) is in India systematically collected and eaten. It seems quite possible that this fact in itself denotes ancient knowledge, if it might not be accepted as pointing to abandoned cultivation and reversion to a wild condition.

Juar run wild.

It is not necessary in a special Indian publication to deal, other than incidentally, with the information that exists regarding foreign countries. The plant is mentioned by most authors who have written on China. Bretschneider (*Tract on Study and Value of Chinese Botanical Works, 1870, p. 9*) has told us that while it is referred to by a writer in the 5th century it is most probably not indigenous to China. The Chinese names for it are descriptive such as *shu-shu*, the millet of the province of Ssu-chuan (Sze-chuen); *lu-su*, the reed millet; and *kao-liang*, the tall millet. Bretschneider in his *History of European Botanical Discoveries in China, 1898*) has focussed in a convenient form the writings of Staunton, Abel, Fortune, and others. One of the Chinese forms is the plant which Montigny introduced into France in 1856 (*see Bull. Soc. d'Acclim. III., 163*) and which was subsequently carried to India and America as a substitute for sugar-cane. Debeaux (*Fl. du Tchefou, 1877, 164*) speaks of

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two Chinese forms, the one cultivated on a large scale on the sandy plains of Yan-tai; the other on the mica-schist hills above Sinenkoo. Hosie (*Three Years in Western China, 1890, 163*) refers to the tall millet, Sorghum vulgare. Lastly Rein (*Indust. of Japan, 1889, 37-51*), as well as a few other authors, describes *Sorgho* cultivation in Japan. He calls it *Durran*, the plant which in Japanese is known as *Merokoshi* and *Takakibi* (the high millet).

We may therefore conclude that in all probability the Sanskrit people first learned of this grain in India, but gave themselves very little concern regarding it. Everything, however, points to its having been cultivated in the peninsula from remote antiquity, and in all probability many of the races of the plant presently met with in that country have been locally originated.

References.

Other authors who may be consulted :—[Varthema's Travels, &c., 1503-1510, Hakluyt's Voy. iv 565; Fuchsius, *Pl. Hist.* (1542) *ccxcvi., p. 261; Tragus, De Stirp. Hist.* (1552) *II., 659; Pena et Lobel, Stirp. advers. nov.* (1570), *p. 14; Pr. Alpinus, Rer. Ægypt.* (1735), *p. 176; Parkinson, Theatr. Bot.* (1640), *1137, f. 3; Morison, Hist. Pl.* (1699) *III., 196; Breyne, Prodr. II.* (1739), *83; Gronov. Fl. Orient.* (1755), *134; Host, Gram. Austriac.* (1805) *IV., 1, fig, 2 and Fl. Austriac.* (1827) *I., 71; Schmidt, Fl. d. Cap. Verd. Ins.* (1852), *158; Martius, Fl. Bras.* (1883), *II., ii., 270-272; Lambrecht, Berichten Land. u. Forstw. in Deutsch. Ost. Africa* (1903), *Vol. I., 398-402.*]

CULTIVATION.

CULTIVATION.

The *Judr* or Great Millet is a very important article of food with the labouring classes of India, and at the same time it has been very imperfectly dealt with by writers on Indian economics. By the natives of India it is regarded as the most wholesome of cereals. The seed is ground into meal and baked into cakes or boiled into a sort of porridge. The parched grain is eaten after being made into numerous special dishes flavoured with salt, sugar, or chillies, and the half-ripe grain (of certain forms or in certain localities) is regarded as a luxury, somewhat in the same way as green maize cobs are variously cooked and eaten. The chemistry of the grain and its value as an article of diet has been so fully dealt with in the Dictionary that it may suffice to refer to that publication.

Varieties and races.

Varieties & Races.—Speaking in a very general sense there are two great crops of *Judr*. Of these one is the *kharif*, which ripens in autumn. The majority of the *kharif* forms would fall under the botanical varieties **bicolor**, **cernuus**, and **vulgaris** proper. They have usually compact heads, the grains are more or less rounded and the floral envelopes almost completely glabrous. The second crop is the *rabi* or that which ripens in spring. It seems likely that most of

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the races placed in this position would be found to fall under the varieties **hians**, **Roxburghii** and **saccharatus**, and to approximate nearer to **S. halepense** than do those of the *kharif* series. They have lax feathery panicles with the grains elongated and the floral envelopes often more or less hairy. As a rule the best grains are creamy white (the extremity only being darker coloured) and of a pearly lustre. It is customary for the grain to be slightly flattened near the apex, a peculiarity often much increased until in some forms the grain becomes almost hooked or even indented. The curved grains are often most highly prized for the purpose of being parched. The glumes or envelopes are usually darker than the grains themselves and they may be awned or awnless. Thus in point of colour—the aspect on which 15th to 18th century writers laid so much stress—almost every shade from pure white to brown or even jet black may be found in either of the groups indicated above. In some forms the envelopes (chaff) are coloured and the grain husk (or seed-coat) white, in others the seed-coat also is uniformly or parti-coloured. So again the floral envelopes may firmly embrace and almost adhere to the seed, while in other conditions the attachment may be so slight that (as in certain barleys) the grain may deserve the description of being naked. It seems probable that Rheede may have had before him one of these *quasi*-naked *juárs* when he figured and described his *katou tsjolam*, to which reference has already been made. Mr. Mollison (Inspector-General of Agriculture in India) says—"The most noticeable differences between varieties are that *kharif*, *i.e.*, rain crops or early varieties, are much more numerous than *rabi* or late varieties. Early or late varieties do best if sown at their approximate seasons. A *rabi* variety may or may not thrive if sown as a rain crop. None of the rain crop varieties are likely to succeed if sown in the *rabi* season." Having thus clearly recognised the existence of definite forms directly adapted to climatic and other conditions, Mr. Mollison would appear to withdraw slightly from his position, when he observes that development "depends more upon the character of the season, the kind and condition of soil, and the method of cultivation than upon differences between varieties." In the experiments conducted by the Farms in the Bombay Presidency it was established that forms of *juár* procured from *goradu* (light) soils, for example, those of Kaira and Baroda, could not be cultivated on the black cotton soils of the Deccan. But that circumstance can hardly be adduced in suport of a belief that centuries of selection have not directly adapted the plants into recognisable cultivated forms. Whether these should be called varieties in the strict botanical sense or only races, is of course a perfectly different issue. Environment is of necessity a primary factor in racial development.

Collection of information on varieties.

Some years ago the Government of India sanctioned a scheme for the systematic collection of specimens and information of ecomomic products. Circular letters were to be issued to all district officers through their respective Governments, in which the extent of our present knowledge and requirements for the future were to be clearly set forth. The first letter of this kind on Sorghum was issued by me in April 1898 and in consequence a very large and highly instructive

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Sorghum vulgare, Pers.,

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series of specimens and descriptive notes regarding them came to hand. These have been critically studied by Mr. I. H. Burkill (the Officiating Reporter on Economic Products). But there still being directions in which further material was desired before a monograph could be written, Mr Burkill, in 1902, issued a second letter in which the following observations occur, in connection with the wild **S. halepense**:—"Its flowers are arranged in a very loose inflorescence and the little grains are soon lost at ripeness, by the breaking of the flower stalk below them. To cultivate and select till the stalk became firm, to make the grains larger and larger, and to mass them into a solid head, have been the objects of generations of cultivators and have been attained:—in the case of the first object, so that no cultivated *juárs* drop their seed by the breaking of the flower stalk; in the case of the second, so that the largest grains seen from India are $\frac{1}{4}$ inch long and $\frac{3}{16}$ ths inch broad; and in the case of the third object, so that the best varieties carry the flowers densely packed, and produce a club-shaped head of seed.

"We find the chief stages of the evolutionary process represented in the great variety of cultivated forms. There are forms with a light feathery inflorescence very like the wild *baru*, except that the grain is larger and the flower stalk does not break at maturity, and from these forms we get a progressive series in which the grain grows longer until it overtops the chaff, and the flower stalk grows shorter until the flowers are aggregated. It is claimed for the more primitive forms of *juar* that birds cannot perch on the heads and peck off the grain; and therefore the people who cultivative little patches in the forests find them more profitable." In a further passage Mr. Burkill indicates some of the more striking instances of new material and new information that had been brought to light. "Burma," he says, "has sent three or four recognisable varieties of the light feathery kinds with small grain, only one of which has been received from elsewhere; Bengal has provided the livid-grained variety named **miliiformis** by Hackel; Sikkim has provided a wretched little plant, which has so far remained undescribed; Madras has sent a variety which is grown extensively under names compounded of *Irungu* and some qualifying adjective, and which has not been received from elsewhere; Central India produces one very peculiar form; Bombay has sent the largest-grained forms of all; Rajputana seems to be the centre in India of the variety **globosus** and the frontier regions of the Punjab produce more than one curious form."

These brief prognostications fully substantiate the statement already made that India possesses a wide range of cultivated forms of this plant. They also abundantly justify the belief that no good purpose would be served by furnishing from standard botanical works a new version of the now stereotyped opinions regarding the chief races met with in India. Mr. Mollison tells us that over one hundred and twenty distinct varieties of *juár* have been identified in the Bombay Presidency alone. He then adds that the number of varieties in general cultivation throughout India is probably very large. The Annual Reports of the Agricultural Depart-

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VARIETIES.

ments, especially those of Bombay, make frequent mention of the forms being experimented with, but as they speak of them under their vernacular names it is impossible to form any conception of the plants indicated. In the Bombay report for 1902-03 some 261 forms are mentioned as received from the Presidency. I can heartily concur in the opinion that India possesses a most extensive and varied assortment of forms and would add that these should be thoroughly investigated before any attempt is made to acclimatise exotic forms. I endeavoured to give some attention to the subject while resident in India, and am abundantly satisfied that the herbarium of the Reporter on Economic Products to the Government of India already possesses material sufficient to justify a monograph being produced that would in many directions no doubt materially upset the commonly accepted views regarding the Indian cultivated forms of **Sorghum vulgare** and very possibly substantiate in some directions at least the speculations already advanced in the Dictionary of Economic Products.

AREA AND YIELD.

Area and Yield.—From the volume of *Agricultural Statistics* published by the Government of India for the years 1897-98 to 1901-02, we learn that during the past five years this crop has occupied in British India approximately 22 million acres. The highest record within the period was close on 24 million acres, and the lowest $21\frac{1}{2}$ million acres. To these figures have to be added $2\frac{1}{2}$ million acres for the Native States, making a grand total of some 25 million acres for all India and Burma. Bombay is the most important province, with usually from seven to eight million acres, and Sind half to three-quarters of a million acres under the crop. Then comes Madras with between four and five million acres. Berar stands next with close on three million acres; the United Provinces follow with about two and a half million acres, and the Central Provinces and Punjab with each just under two million acres. Upper Burma has a fair amount, approximately one million acres, but Lower Burma, Bengal, and large portions of Madras, being rice-producing countries, have only small areas under *judr* (or *cholam* as it is called in South India). The average in Bengal is about 130,000 acres.

An almost identical result exists in the Native States: *judr* becomes important on land not inundated. Out of the total, Gwalior takes usually close on half, that is a little over one million acres. This is followed by Mysore with about half a million acres, by Kotah State with 350,000, and by Tonk and Jaipur having about the same acreage between them.

It will be seen that in the Dictionary (*l.c. page 298*) it was estimated that when fuller statistics than then existed were forthcoming it would possibly be found that about 25 million acres were under this crop. The returns to hand which fortunately deal with the whole of India much more satisfactorily than was the case a few years ago,

AREA AND YIELD.

confirm the acreage as just stated. It was further estimated in the Dictionary that a yield of 6 maunds (or say 500 lbs.) an acre might be a safe though probably a low average for the crop. To be rather under than over the mark therefore this would come to an annual production of, say, 5 million tons of grain. There are two possible errors in that estimate :—(*a*) *judr* is largely grown as a mixed crop, very often with pulse, but as the produce may be viewed as contributing to the food supply the error involved may be disregarded : (*b*) some portion of the *judr* area may be concerned in the production of green fodder. But this second possible error would seem mitigated by the circumstance that the green *judr* crop is usually returned as fodder and therefore does not materially affect the *judr* area and yield given above. Any error that may exist would seem more than covered by the low estimate of yield accepted and by the further circumstance that there is frequently more than one or even more than two crops of *judr* taken off the especially suitable tracts of India, according to the season and quantity of rainfall. Mukerji (*Hand-book of Ind. Agric. 1901, p. 254*) says of *judr*, "It yields a nourishing grain about the same quantity per acre as wheat or rice (900 lbs.) and ten times as much in fuel and fodder as ordinary cereal crops." Mr. Mollison (*Text-book on Ind. Agric.* (*1901*) *III.*, *8*) speaking of the Deccan *kharif judr*, remarks, "An average crop in the Deccan will vary, according to the quality of soil, from 500 to 900 lbs. per acre of *jowár* and 100 to 200 lbs. subordinate pulses, with 350 to 450 bundles of *kadbi*" (fodder). Referring to the Gujarat *rabi judr* Mr. Mollison continues, "An acre produces 800 lbs. to 1,000 lbs. grain and 300 to 400 bundles of *kadbi*, each bundle weighs 4 to 6 lbs. The fodder is usually of excellent quality, because the crop stands fairly thick upon the ground and the stalks are neither very tall nor very coarse. A *rabi* crop in other black soil districts yields generally in a fair season 550 to 700 lbs. per acre." In the Report of the Experimental Farm at Surat for 1903 the yield is given as 1,213 lbs. grain, by-products 3,974 lbs. the value of the out-turn Rs. 34-3-1, and the cost of cultivation Rs. 30-14-0 an acre. These returns, as also Mr. Mollison's figures, may be accepted as in accord with the numerous crop experiments that have been performed in Bombay.

The average yield of 500 lbs. an acre may thus be viewed as sufficiently accurate for all practical purposes.

DISEASES, MANURE, ROTATION.

Diseases and Pests : Manure and Rotation—The Sorghum crop is exposed to four chief adverse circumstances :—(1) fungal blights; (9) parasitic flowering plants; (3) insect and other animal pests; and (4) climatic disturbances. It seems, however, hardly necessary to again go over the ground so elaborately traversed in the Dictionary. The reader is therefore referred to that work for full particulars regarding the Rust, Smut, and Bunt of Sorghum (l. c. *pp. 298-302.*) Mr. Massee's *Text-book of Plant*

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DISEASES.

Diseases (*p. 216*) may also be consulted for more recent particulars regarding smut. Much advantage might be anticipated from the systematic washing of the seed in hot water (at a temperature of 135°-150° F.) or in sulphate of copper ($\frac{1}{2}$ p. c. solution) before being sown. By this process the crop would be protected against smut and bunt. Of the parasitic flowering plants found on this crop the most curious is the small **Striga** (known in the vernacular as *tavli* or *taluk*), which sometimes effects frightful havoc. One or two parasitic insects do much damage (such as the sugar-borer and an aphis), but birds and squirrels are by far the most destructive. To safeguard the crop the owner and the members of his family or his retainers, watch the crop from sunrise to sunset for some 20 days before the harvest. For this purpose they sit on elevated platforms, placed at certain intervals all over the field and make discordant noises by beating on old tin cans or cast by slings small stones or hardened pellets of mud at the flocks of birds which every now and again settle on the field. The climatic disturbances may be briefly stated as want of rain at the proper season, excessive humidity and cloudy weather, or unnaturally high temperatures. In a further paragraph, while dealing with the production of this plant as a source of fodder, reference will be made to the evil reputation of the stems for becoming poisonous. This peculiarity is not constant, though it often occurs in an epidemic form such as to justify belief that the germ concerned in the production of the poisonous property is dependent upon accidental climatic conditions. The plant stunted because of deficiency of rain is always dangerous fodder for cattle. A study of the races of the plant, more critical than hitherto attempted, might therefore be looked to as likely to result in the discovery of forms better suited to certain tracts of country than those at present being grown. The discovery might also be made of forms better suited for cultivation when the rains have been abnormally delayed than those at present known. On this aspect Mr. Mollison's pertinent observation may be given here:—"Some varieties mature much more quickly than others. It is important to know which varieties reach maturity earliest; because, after a period of scarcity or famine, varieties which produce grain and fodder in the least time would be most in demand."

Poisonous if diseased.

ROTATION.

The advantage of sowing mixed with the bushy pulse *tur* (**Cajanus indicus**) turns very largely on the protection afforded from severe droughts and destructive winds. Inter-cultivation can hardly be described (as has been done) as a rotation. The action of leguminous crops on the soil is, however, valuable and a mixed crop may on that account serve part of the purpose of a rotation. The rotations most frequently seen are Cotton, and *Juár* with *tur* mixed; Cotton, *juár, til*; Cotton, *juár, san* hemp (the last often ploughed in as a green manure); or cotton, *juár*, fallow. *Juár* is supposed to participate in the manure and cultivation bestowed on the cotton. The Farm experiments have proved the three rotations distinctly preferable. The special value of the use of *til* or *tal* (**Sesamum**) lies in the fact that being a late crop it allows of the land being thoroughly ploughed every third year. Besides the plants mentioned many others are used, but as these may now and again, be referred to in the

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STORAGE OF GRAIN.

observations below nothing further need be added to the scheme of rotation just indicated.

Storage of the Grain.—Numerous writers have recently described the method adopted in the Deccan to preserve the surplus stocks of this and other grains. This is accomplished in deep underground pits or *pevs*. The pits are formed where the sub-soil is more or less impervious. A shaft is sunk, perhaps to a depth of six feet and a lateral cavern scooped out. This is lined with straw and the grain poured into it. A large stone or board is placed against the mouth and the shaft filled up with earth so completely that the presence or the location of the store can with difficulty be made out. This was the system that prevailed before the opening up of the country by road and rail rendered transference of produce from localities of superabundance to those of scarcity, both more profitable and expeditious than the system of storage against necessity. A continuation of abnormal abundance often converted stores into a loss rather than gain. Peved grain when taken out after 5 to 10 years looks all right, but it has a strong earthy smell and a bitter taste, and it rapidly turns bad if not consumed quickly.

It may be useful to indicate very briefly recent information of a practical and local nature regarding the cultivation of this plant as a source of grain, and for this purpose it may perhaps be the most useful course to deal with the provinces in the sequence of their importance as sources of supply:—

AREA IN BOMBAY AND SIND.

Bombay and Sind.—It would appear (*from the Annual Reports of the Department of Land Records and Agriculture, especially that of 1902-03*) that in this Presidency cereals occupy from 70 to 75 per cent. of the cultivated area and that of the mean acreage from 27 to 29 per cent. is devoted to this crop. In other words, there are usually from 7 to 8 million acres under it or approximately double the area devoted to wheat, rice, and barley combined. The chief districts showing a high percentage may be enumerated here, the figure within brackets following each name denoting the percentage of this crop in 1902-03:—Sholapur (73), Bijapur (51), Sukkur (41), Belgaum (38), Poona (35), Upper Sind (34), Satara and Broach (each 32), Dharwar, Ahmednagar, and Surat (each 29), other districts smaller percentages. The province of Konkan (the districts of Thana, Kolaba, Ratnagiri, and Kanara) as also most low-lying tracts and coast districts have remarkably little or no *judr*. Mention has already been made of the large number of known forms of this plant, under cultivation in this Presidency. Discussing the merits of those grown at the Surat Experimental Farm, the Superintendent, in his Report, 1902-03, speaks of 23 having been found to be superior grain varieties. He adds that 269 forms were under experiment.

Races in Bombay and Sind.

In the Dictionary of Economic Products (1893) special stress was laid on the relatively greater importance of the *rabi judr* crop

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in Bombay than in the other provinces of India. It follows accordingly that a larger percentage of the Bombay forms of the plant might be looked for as belonging to the group with open feathery panicles and saccharine stems. And it has already been shown that the knowledge in these plants is by no means recent: Gujarat Sorghum was famous at the time of the *Ain-i-Akbari* (1590 A.D.). Since the date of the Dictionary much progress has been made. Many valuable reports and special publications have appeared, such as those in connection with the Experimental Farms. The Crop Experiments, and the Agricultural Departments, &c., Mr. Mollison tells us, in his *Text-book*, that *judr* is the staple grain crop where black and mixed black soils predominate, provided the rainfall is moderate and well distributed. Where rainfall is excessive, it gives place to rice, and on sandy loams and shallow soils to *bájri*. For the *kharif* crop 40 to 45 inches of rain a year and in some of the best districts only 30 to 35 inches is all that is required. *Rabi judr* as just stated is also extensively grown and success with it depends on two conditions—(*a*) a soil both sufficiently dense and deep to retain moisture, and (*b*) sufficient late rains. The September and October rains are especially important for *rabi judr*, and if a moderate fall occurs in November and December, the crop is assured. The best *rabi judr* is perhaps that of Broach. In that district the soil gets sodden during the monsoon and is therefore unsuited for *kharif judr*. It is generally sown alone, but in the Deccan and Southern Maratha country safflower and linseed are grown along with it.

Requirements.

Mr. Mollison refers his account of this cereal to the sections shown in the following abstract of the practical information given by that distinguished agriculturist:—

Crops.

(A) **The Kharif Juar of the Deccan**:—The land should be ready for sowing by the end of June: later sowings are not so satisfactory. The amount of seed to be used depends to a large extent on the kind cultivated. Large headed forms require more space. But the ordinary rate of seed is 6 to 8 lbs. an acre along with $1\frac{1}{2}$ to $2\frac{1}{2}$ subordinate pulses. The seeds are mixed and drill sown, the rows being 14 inches apart. In successful cultivation the crop is hand-weeded as well as hoed once or twice. The crop will come into flower in August and September and ripen in October and November.

(B) **The Kharif Juar of Gujarat**:—It usually alternates on black soil with cotton: after the removal of the cotton stems the land is repeatedly harrowed and scarified in April and May, but no ploughing is as a rule given since *judr* likes a firm seed bed. In June or July the seed is drilled in rows 20 inches apart. When the crop stands 9 inches high it is again hoed and the plough is

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BOMBAY AND SIND. Crops.

passed between the rows of seedlings. The principal crop is ready five months after sowing.

(C) The Rabi Juar of Gujarat:—In Broach this form of *juár* is called *shialu.* It is drill sown in September or October after one ploughing and several harrowings of the soil. The seed is sown at the rate of 7 to 8 lbs. an acre. The rows are 20 inches apart, and the seedlings appear in the furrows. The crop is twice intercultured with the bullock hoe. "As the ears begin to fill, the stalks are tied up to each other so that they may not be lodged." This is only necessary in a good year, with a heavy crop. Harvest takes place in February to March or five to six months after sowing.

MADRAS AND MYSORE. Area.

Madras and Mysore.—According to the Agricultural Statistics of British India 5,103,795 acres were under *cholam* (*juár*) in 1901-02. During the five previous years (1899-1902) the smallest acreage devoted to the crop was 4,375,168. The districts assorted according to the extent of this cultivation, during 1901-02 (omitting the three last figures), were:—Bellary (924), Karnál (765), Coimbatore (673), Cuddápah (493), Nellore (455), Anantpur (417), Kistna (416), Madura (223), Trichinopoly (167), Godávari (143), and Tinnévelly (101). In some of the districts not named its place is taken by *kumbu* (*bajra*) or by *ragi.* Thus where rice is either not suitable or not popular, an abundant food-supply is obtained by the people of South India from one or other of the Millets named.

Races.

Very little of a trustworthy nature can, however, be learned regarding the indigenous methods of cultivation of this plant. Most South Indian writers have concerned themselves with efforts to acclimatise the foreign Sorgo and Imphy. In the *Annual Report of the Department of Land Records and Agriculture* for 1901-02 mention is made of experiments with the *Irungu cholam.* In several other publications we read of as many as 96 different kinds of *cholam* being known. While that is so there has been published little or nothing of a practical and original nature from which useful particulars could be abstracted for the purposes of this work.* Mr. E. Krishna Rao (*Journ. Agric. Students Associat. 1886, II*) gives some useful suggestions regarding the crop. He, for example, speaks of the white *cholam* as a four months crop, sown in November and harvested in February. Other forms, *viz.*, the red, the yellow, and the small white *cholam* are sown in April and harvested in July. The land is ploughed several times and the seed sown broadcast. When the crop has grown a foot high it is watered and three or four days later hoed. If the soil be clayey and sufficiently

* While this number of the Agricultural Ledger was in the press a paper, entitled the Great Millet or Sorghum in Madras by C. Benson, assisted by C. K. Subba Rao, has appeared, being Bulletin No. 55 of the Madras Department of Agriculture.—ED.

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manured 6 to 8 waterings and hoeings are considered sufficient. It is presumed that a yield of 500 lbs. per acre would be a safe average estimate. In the crop experiments figures have been published of actual returns that range from 220 to 1,690 lbs. In Mysore the published averages have been 453 to 800. **MADRAS AND MYSORE. Outturn.**

Berar & Hyderabad.—Mr. F. W. Francis in his *Agricultural Bulletin No. 3, of 1900*, has published one of the most valuable contributions to the study of *juár* that has as yet appeared. This was written by Mr. S. Harcourt King and while professedly an account of the crop in Amraoti is, in the opinion of Mr. Francis, fully applicable to all the Hyderabad Assigned Districts (Berar). **BERAR AND NIZAM'S DOMINIONS.**

Before furnishing the more remarkable points brought out in the above Bulletin, in order to preserve uniformity with other provinces, it may be desirable to furnish here the particulars of area of cultivation from the Imperial Agricultural Statistics. In Berar 2,884,875 acres were devoted to this grain in 1901-02 and during the five previous years the lowest return was 2,658,246 acres. Hyderabad (Nizam's Dominions) furnishes no returns. Mr. Francis says that *juár* is undoubtedly the most important grain crop of the province—more than one-third of the total cultivated area being devoted to it. It occupies fully 250,000 acres in excess of all other crops taken together. The Famine Commission of 1876 estimated that it absorbs 35·10 per cent. of the total cultivated area and 68·31 per cent. of the food area of the province. It certainly constitutes the staple food of the cultivating and poorer classes, while the stalks, known as *karbi* or *kadba*, provide the requisite cattle fodder during the greater portion of the year, when grazing is not available. It has been estimated that about one-fifth of the production is sold and exported. There are no less than 43 varieties of the plant grown and twelve of these come under the denomination *wani* (*bhátwani, jodwani, bawani, &c., &c.*) or forms that are not allowed to mature but are baked in hot ashes and eaten green, when the grain is tender and in the ear. One of these is distinguished under the name *andhali*, is completely covered by the husk and is not visible. Of the other forms four groups are formed according to their value as sources of bread. **Area.** **Races.**

These are :—

(1) The Yellow *juárs*, such as *dhámaná, lahi, ramkeli, amneri,* and *thengani*—the bread made from these is regarded as the best of all.

(2) The Whitish *juárs*, such as *jagdhan, latura, motichur, shálu* or *sháhu, &c.*—the bread made from these is hard and wanting in taste.

(3) The Reddish *juárs*, such as *gunji, lálgunji, kadpáda,* and *ganeri*—bread made from these is of the same colour

BERAR AND NIZAM'S DOMINIONS. Races.

as the grain. The *kadpáda* is a plump grain superior to *lálgunji*.

(4) The dirty-coloured *juárs*, such as the *kálbondi*. This and the *motichur* are seldom used for bread but are utilized in making *láhi* (parched grain).

The variety called *dhamna* is that most generally preferred. The *ramkeli* is selected for inferior soils and it is less liable to be affected by scanty rainfall. Seed is usually stored in ear in a convenient corner of the cultivator's house and not touched until sowing time arrives—handling is supposed to increase liability to be attacked by insects. It is regarded as essential not to store seed in proximity to tobacoo, chillies, garlic, or *moha*. Immediately before sowing the seed is soaked in a solution of asafœtida and water or of cows' urine, the latter being the most general practice. The custom of soaking in hot water or pickling (as it has been called) in sulphate of copper, to destroy germs of smut, does not appear to be followed. Unless the soil is very hard or full of weeds, *juár* lands are ploughed once in four or five years only, and then in April or May. Instead the soil is simply harrowed. This is done three times and on the last occasion after the first fall of rain. The cultivator is alive to the value of manure, but his difficulty lies in obtaining it. *Juár* is, however, mainly cultivated without any manure or the land is manured once in two or three years only. It is rated with cotton, sesamum, gram, wheat, *lakh* (**Lathyrus sativus**), and tobacco, but cotton is the most important because like *juár* it is a *kharif* crop. It follows that any material expansion of the cotton area would mean a restriction of that of *juár*. The *juár* is usually grown as a mixed crop, with certain pulses. The continuous cultivation of *juár* deteriorates the soil and causes the growth of a parasitic weed *talupa*, *taluk*, or *tavli* (**Striga lutea**) which is checked by rotation, more especially with *til* (**Sesamum**).

Method of Cultivation.

The first week in July is the best time to sow *juár* and if delayed till the last week the crop is believed to be inferior. Immediately the cultivator has sown his cotton crop, he gives attention to *juár*. The grain is drill-sown by an instrument called the *tiphan*. Sundays, Wednesdays, and Fridays are considered auspicious days for sowing and the sower begins operations by keeping his face either to the north or to the east. But the seed cannot be winnowed nor rubbed with cows' urine in the presence of a woman who has applied *kajal* (lamp black) to her eyes nor can *kajal* be used by the female members of the household until sowing is complete. Perhaps this may be a consequence of a belief that the use of the cosmetic causes the grain to be smutted.

Sowing is delayed not only by excessive rain, but by the absence

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BERAR AND NIZAM'S DOMINIONS. Method of Cultivation.

of sufficient rain. A moderate and opportune fall of rain is needed for successful germination, but this is proportionate to the nature of the soil. A good soil requires less rain than an inferior one. When the shoots appear they are often seriously injured by an insect known as *maral*, but this is kept in check by timely rains. Cattle also do much damage. In fact until they are 6 inches in height the seedlings are tender; after that fairly hardy. Weeding is done three or four times at intervals of a fortnight. This is accomplished either by hand or by the *dowran* (or harrow), the latter loosens the soil and throws it up against the plants. When the plants come up too thick to ensure a good grain crop a certain percentage are uprooted.

Judr is never specially watered in Berar apparently, nor is it customary to grow the crop on land systematically irrigated. This is the rule for the grain crop, but when required to make up deficiencies of fodder, thickly sown and irrigated crops are taken. But fodder *judr* is not raised since the grain crop being so abundant the fodder supply is usually sufficient. *Judr* requires good rain in August and it comes into ear from three to four months after being sown, and ripens in five months (November to December). After having set its seed, rain is hardly necessary and the crop is not then liable to any special diseases except the depredations by birds, &c. But should rain hold off at the time of forming the ear, several insect and parasitic fungal diseases may appear and do much damage. A good shower of rain is, in the belief of the cultivators, the only effectual remedy for these calamities. In conclusion it may be observed that there is remarkably little *rabi judr* raised in Berar. Mention is made of this crop in connection with Baldana district.

Outturn.

It has been estimated that the value of the produce is ordinarily 25 per cent. in excess of the cost of cultivation and may even go up to double that amount. Mr. Francis concludes his most admirable paper (from which the above jottings have been abstracted) by a series of tables showing the acreage devoted to the crop from 1888-89 to 1897-98. In another place he gives the results of certain crop experiments. These show that in a good season the yield would be 833 lbs. to the acre and after making all allowances an estimate of 600 lbs., he thinks, would be a fair average production.

In Hyderabad it is stated that there are two crops of *judr*: the one sown from the 6th June to the 17th July and reaped from the 22nd October to the 30th November. The second crop known as white *judr* is sown between the 25th September and the 3rd November and reaped between the 17th February and the 15th March.

A writer in *The Indian Agriculturist* (*March 1886*) says the natives recognise many forms of the plant, six being *wani* forms. By far the most extensively grown, he tells us, is the *dhamni* or

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SORGHUM vulgare, Pers. | Sorghum vulgare, Pers.,

BERAR AND NIZAM'S DOMINIONS. Races in Hyderabad.

amnira. This is a yellow coloured grain with a bright glistening bran. It grows to a height of 10 to 11 feet, whereas the next most popular form—the *latura*—does not exceed six or seven feet. This is a white grain which when ground affords a fine white flour. The *jugdan* is a *kharif* form that has the advantage of ripening quickly and thus of allowing a *rabi* wheat crop to be taken from the same land. *Judr* is most successfully grown on black cotton soil. The land is prepared in March and April, but ploughing is rarely resorted to more frequently than once in 20 years. Manure is rarely given and the seed is drill sown. The crop takes five months to ripen.

UNITED PROVINCES. Area.

United Provinces of Agra & Oudh.—The *judr* area in Agra was returned at 2,090,660 acres and in Oudh at 343,568 acres during 1901-02, and during the five previous years the lowest return was in 1899-1900 when the two provinces showed an area of 2 million acres, and the year following their highest record, namely, a little more than $2\frac{1}{2}$ million acres. The districts with the highest areas of production were (omitting the last three figures):—Jhansi (172), Mutra (159), Banda (152), Cawnpore (150), Hamirpur (143), Aligarh (119), Agra (108), Meerut (106), Bulandshahr (100), Allahabad (97), Fatehpur (89), Etah (79), Budaun and Jalaun (each 78), Mainpuri (77), Farukhabad (73), Etawah (64), &c. No distirict in Oudh has more than 55,000 acres under the crop. In Messrs. Duthie and Fuller's account of this crop mention is made of three well-marked varieties: (1) the double-seeded form (two grains within the single husk), (2) a dwarf kind grown at Allahabad, (3) the variety known as *chdhcha* in Cawnpore, in which the grain is completely covered by the husk. In the Report of the Cawnpore Experimental Farm for 1901-02 mention is made of 90 varieties being under cultivation. The yield is given at 10 maunds grain for irrigated land and 8 maunds for unirrigated. In the reports of crop experiments returns ranging from 440 to 820 lbs. have been ascertained.

Races.

In many reports that deal with the districts above mentioned the statement occurs that *juár* is as universal in the *kharif* crop as wheat and gram are in the *rabi.* This remark is specially true of the black soils. In the Annual Reports of the Department of Land Records and Agriculture, frequent mention is made of this crop. Many varieties were experimented with at the farm, and *jogia, bansmati,* and *safeda* were regarded as the best. Subsequent to the date of the appearance of the Dictionary article on Sorghum no detailed paper has appeared regarding the cultivation of this plant in these provinces.

CENTRAL PROVINCES. Area.

Central Provinces.—These provinces had an area of 1,964,763 acres devoted to the crop in 1901-02 and during the five years pre-

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CENTRAL PROVINCES. Area.

vious their highest record was in 1900-01, *viz.*, 2,154,861 acres, and their lowest in 1898-99, 1,709,334 acres. The districts in order of importance may be here mentioned, the figure after each denoting the acreage, less the three last figures:—Nagpur (474), Wardha (329), Chanda (236), Chindwara (194), Nimar (196), Saugor (108), Betul (89), Hoshangabad (67), and Damoh (61). It forms the chief food of the working class, wheat and rice being alike but little used by them. The white *judr* constitutes the chief food of the people. In certain districts such as the Upper Godavery and the neighbourhood of Sironcha in Chanda district, a *rabi* as well as a *kharif* crop is obtained. Repeated mention is made (in reports on this plant) of a cold season form known as *ringni.* Some writers even speak of this as a hot-weather plant that has recently been successfully grown as a cold season crop. It is commonly produced in the wheat fields of the rice-country of Ramtek and Umrer. Sir J. B. Fuller published in 1874 a *Note on the Outturn of Land under the Chief Crops in the Central Provinces* in which he gives most useful particulars regarding *judr*. He points out that the loss in *judr* through its being grown as a mixed crop with a pulse, (mostly *tur*) is very little indeed, so that the pulse is a clear gain. The yield per acre averages from 450 to 950 lbs., 500 lbs. has been accepted as the average standard. Mr. Fuller further points out that Nagpur, which has the largest district area, is also the chief importing province and that it draws on Berar. This is due very possibly to the place of *judr* being taken by linseed and cotton. In the *Settlement Report for Seoni (1900, p. 17)* it is observed that a few years ago *judr* was of very little importance in that district, but since the last three years it has been greatly extended, and has outrun the area under wheat. In recent Annual Reports of the Director of Land Records and Agriculture, interesting particulars will be found of valuable experiments made with a view to improve the quality of the *judr* and the cotton grown, as also the methods of cultivation pursued in the districts of Bilaspur and Raipur. Trained ploughmen had been sent from the Government farm furnished with superior seed and improved ploughs to prepare and sow certain fields. The result would appear to have been so satisfactory that many indents were subsequently made by the cultivators for a supply of the improved seed. Demonstration farms have since been organised where local men, specially trained at the Government farm, will continue to demonstrate the advantages of the improvements recommended.

Method of Cultivation.

PANJAB. Area.

Panjab.—According to the Official Agricultural Statistics the area under the crop in the Panjab might be regarded as giving evidence of decreasing popularity with the cultivators. In 1897-98

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PANJAB. Area.

the area was 2,386,049 acres, and it fluctuated downwards for the succeeding years till 1901-02 it stood at 855,025 acres, and in 1902-03 a slight increase took place, the area having been 1,206,775 acres. And what is more significant, the district returns show that whatever may be the cause for the decrease in production it has practically taken place throughout the province. The districts of chief importance are Jhang (120, omitting the last three figures), Dera Gazi Khan (95), Hissar (declined from 248 to 13), Rohtak (from 267 to 29), Gurgaon (from 133 to 56), Karnal (from 201 to 61), Ludhiana (from 104 to 22), Ferozepore (from 147 to 46). In certain crop experiments performed in the Panjab in 1892, the yield ranged from 276 to 800 lbs. per acre.

Races.

There are said to be many races of the grain, and in most districts it would appear as if special fodder (*chari*) forms had only recently been systematically cultivated. The Gazetteers afford useful particulars, but it would seem that since the date of Baden Powell's *Panjab Products* no publication has discussed the *juár* cultivation of the province as a whole. The Dictionary article should therefore be consulted since it gives an abstract of the chief opinions hitherto published.

NORTH-WEST FRONTIER PROVINCE.

North-West Frontier Province.—*Juár* is not an important crop in Hazara, Peshawar, Kohat, Bannu, and Dera Ismail Khan, the total acreage having averaged for the province 13,174 irrigated and 46,445 unirrigated land.

BENGAL AND ASSAM.

Bengal & Assam.—Although grown by the hill tribes to a limited extent, *juár* cannot be regarded as an important crop in these provinces. The unimportance of *juár* and in fact of all millets may be gathered from the opinion of the Famine Commission, namely, that famine in Bengal meant essentially the loss of the rice crop sown in April to June and reaped from November to January. The loss of the *bhadoi* or intermediate crops, which consist largely of India-corn, millets, etc., would not produce famine, not even scarcity.

Area.

The area under the crop is in Bengal less than 150,000 acres and in Assam the figure of 5 acres has been quoted. In the Annual Report of the Bardwan Experimental Farm (1901-02) particulars are given

Races.

of experiments with black-seeded and also red-seeded forms as fodder crops. Further experiments with other forms are alluded to by the Director of Agriculture in his Annual Report for 1902-03.

BURMA.

Burma.—In the Official Agricultural Statistics this province is referred to two sections, Upper and Lower Burma. In the former the area under *juár* is important and has further been manifesting a

Area.

constant tendency to expand. In 1897-98 it stood at 615,145 acres and in 1901-02 at 1,028,844 acres. In Lower Burma—the rice-country—the crop is very unimportant, in 1901-02 there were only

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1,000 acres under the crop. The chief districts are Myingyan (237, omitting as usual the last three figures), Pakokku (210), Lower Chindwin (186), Magwe (156), Sagaing, (95), Meiktila (94), &c. The results of the crop experiments have shown the yield to be from 328 to 875 lbs. an acre. BURMA. Outturn.

Varieties.

Recent Settlement Reports have furnished some useful particulars regarding this crop. Speaking of Myingyan we read that "the seed was said to have been introduced" after the famine of 1856-57. Mr. Blanford reports having seen it in Pagan in 1862. There are two forms recognised—1. *sanpyaung*, grown for human food : it has a round white seed with yellow husk, and 2. *kunpyaung*, grown for fodder but not exclusively so : it has both red and brown grains. Both crops are sown in July and August and gathered in December and January. The stalks which often run up to 18 feet in height are given to cattle after being chopped up and mixed with water.

Speaking of the Meiktila district we read in the Settlement Report that *juár* is one of the chief up-land crops. It is in greater request as an article of food in the western than in the eastern portions of the district owing primarily to the fact that the scope of the cultivation of paddy is somewhat limited in the former. There are three kinds,—1. *Kun-pyaung*, has a reddish-brown seed, is not deprived of its husk on being threshed and gives the highest return. 2. *San-pyaung*, gives the lowest return in proportion to the seed sown, since in the process of threshing and winnowing it is entirely cleared from the husk, so that nothing but the little pearly yellowish seeds remain. It has a better appearance than the *kun-pyaung*, and yields after being milled 11 as compared with 8 from the *kun-pyaung*. 3. *Pyaung-net-si :* this is not very extensively cultivated. It has a jet black husk and forms (like *kauk-hnyin* rice) a glutinous mass when cooked and is used for cakes and other sweet confections. The *juár* is sown in August and September and reaped in January and February, being a six months crop. It grows well in paddy fields provided water is not allowed to stand in the fields, and when scarcity of water prevails it often takes the place of paddy. The ground is prepared by harrowing the surface at least ten times and the seed is then broad-casted.

Fodder Supply.

FODDER.

Ripe & Green Stems.—The *juár* crop is not alone of value as a food for man. Its stems constitute the chief cattle fodder (*chari*) of a large portion of India. The first signs of famine directly induced by the loss of the *juár* crop are the starvation and death of the cattle. It thus follows that in India it is the ripe stems and leaves

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FODDER.

(the straw, it might be called) which constitute the Indian *juár* fodder. Here and there special races of the plant are grown as a supply of green fodder. Mr. Mollison speaking of the Bombay Presidency mentions some six indigenous forms of fodder *juár*, and as these are possibly representative for the whole of India an abstract of his information may be useful :—

Varieties used for fodder in Bombay.

1. **Sundhia.**—Perhaps the best fodder variety. It grows to perfection in North Gujarat on deep alluvial sandy or sandy loam soils either as a rain crop or under irrigation in the hot weather, and in the Deccan it does only moderately well as an irrigated crop, either in the cold or hot seasons. It should be sown broad-casted 50 to 60 lbs. of seed to the acre. When in flower it should stand very dense and be 9 to 11 feet in height with stalks no thicker than those of strong wheat. There are two sub-races of this plant known as *farfaria* and *amaria* (*See Experimental Farm Report, Bombay, 1898, p. 4.*) According to many writers the *shalu* is a special rabi form of *sundhia.*

2. **Dudhia.**—This is met with on the light coloured soils of Kaira and Baroda. The head of the grain is small and dense. It is usually grown mixed with *sundhia.*

3. **Nilva.**—This is the best Deccan (Poona) fodder for the monsoons. It is sometimes grown for its grain, but is chiefly of value near populous centres as a supply of fodder. It has a small moderately dense head of inferior seed, but is a stronger more leafy plant than *sundhia,* hence the seed to the acre should not exceed 40 to 45 lbs. It does best on medium black soils and does not mature quickly. If cut green and a fair stubble is left, a second or even third crop may be obtained, if rain be favourable or irrigation given. This is a valuable property possessed by certain forms of *juár* only. It has, moreover, in the Deccan become so inured to climatic conditions often highly unfavourable that it will survive when other forms fail. Mr. Mollison observes, "We have repeatedly grown at the Poona Farm over 30,000 lbs. per acre of green fodder from *nilva.*" (*See Experimental Farm Report, Bombay, 1896-97, p. 3.*)

4. **Utávli** is another Deccan form with loose upright heads of grain. It grows more quickly than *nilva* and is particularly suited for sowing midway between the *kharif* and the *rabi* seasons. It does very well on moderately light as also on medium black soils. As a cold weather irrigated crop it does better than *nilva.* (*See Farm Report, 1897-98, p. 27, also 1902, p. 3,* where the dry weight outturn per acre is given as 10,623 lbs.)

5. **Hundi** and 6. **Kálbondi** are recommended for cultivation as irrigated crops and should be sown any time between November and February. They do best on medium black soils of fair depth. The stalks are tall and rather coarse and woody. The seed should be broadcasted 40 lbs. an acre and the field irrigated every 10 days in the cold season, and every 8 days in the hot weather. Both these crops, if cut for fodder, before they reach maturity, send up a second crop and several stalks shoot from one stool.

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FODDER.

Yield.

Mr. Mollison further observes :—" No other crops can compare with the sorghums in yielding a heavy weight of green fodder of good quality. Succulent fodder of this class is specially valuable in the hot weather for all farm animals, and *hundi* and *kálbondi* are the most suitable varieties yet found for the purpose." The Annual Reports of the Director of Land Records and Agriculture as also the Reports of the Experimental Farms in Bombay have for years past contained much useful information regarding Sorghum and a few that are of special value have been cited above.

As fodder in Panjab.

In the Panjab Sorghum fodder (*chari*) is a fairly important crop. The Gazetteers and Settlement Reports as also the Annual Reports of the Director of Agriculture contain useful particulars, but it is impossible to ascertain the special local forms that might correspond with or be supplemental to those briefly indicated regarding Bombay. So in the same way many reports and technical publications refer to the fodder (*karbi*) of the Central Provinces, and also of the United Provinces. It is stated, for example, in connection with the Nagpur Farm that it had been ascertained that an economy was effected by giving to cattle chopped canes in place of entire canes of sorghum. The Annual Reports of the Department of Land Records and Agriculture and of the Saidapet Farm in Madras give certain particulars of experiments that had been made with the acclimatisation of foreign sorghums and to some extent also with the indigenous *cholam*, but very little of a critical nature has as yet been published regarding special fodder forms of the plant peculiar to the Presidency and of the native practices in their production.

In the Central Provinces.

In Madras.

ENSILAGE.

Ensilage.—Mr. Mollison describes the manner of preserving Sorghum fodder followed in the Southern Maratha Country. " The bundles are built into neat oblong heaps in the field. Each heap is built with a slope from the ground to the ridge, and when complete is protected along the sides, ends and top with big lumps of black soil, which are built or packed closely together. These heaps when complete look like large boundary marks. Cattle can freely graze over the stubble, but can get no access to the stored fodder." Dr. Voelcker has expressed himself as opposed to the introduction into India of the European methods of siloing Sorghum fodder. The reports published by the Experimental Farms of India are as a rule unfavourable.

Mr. Mukerji (*Handbook of Ind. Agric., p. 255*) says that Sorghum fodder may be sown " in May, and sowings should continue through June and July, that there may be a succession of fodder crops of first, second, and third cuttings from July to March or April, a portion of which can be dried and preserved for use from April to June. The dried stalks should be stacked and thatched."

WHEN IS SORGHUM POISONOUS ?

Poisonous Property.—It has been already observed that the name *bikhonda* given to the wild S. halepense may be intended to denote the well-known poisonous property which that grass some-

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times manifests. It may perhaps be accepted as a further proof of the derivation of at least the fodder-yielding cultivated forms of **Sorghum vulgare** from this wild plant, when it is added that under certain circumstance, the cultivated Sorghums also become poisonous. In this connection attention may be invited to the fact that the Hemp Drugs Commission in their Report (*p. 156*) and more recently the Excise Commissioner of the Central Provinces have made known a new use of the root of the *juár* plant that seems to have escaped the observation of previous writers. It would appear that *juár* root is employed to increase the potency of Indian hemp (*bhang* and *ganja*) as also country liquor, but is viewed as too powerful to be used by itself. A poison residing in the roots is certainly remarkable and worthy of the most careful and searching future inquiry, but it may be added that it is said to occur also is the root of rice, and so far as *juár* is concerned in the cold weather or *ringni* (Central Provinces) and *shalu* (Bombay) varieties only.

Toxic body in the root of some races.

In the *Dictionary of the Economic Products of India* (*Vol. VI., Pt. III.* (1893) *p. 304*) it was observed that whether due to an insect (as the natives appear to think) or to some physiological change in the growth of the plant, due to climatic disturbances, the *juár* stems become occasionally poisonous. The occurrence of this poisonous property is moreover often simultaneous over a large tract of country, appearing and disappearing within certain fixed limits of time and locality. It would thus seem that the effect of climatic disturbances in modifying the quantity and quality of the crop has not received the degree of consideration which it demands. Need it, therefore, be added that the study of the races of **Sorghum**, in relation to climate and soil is of the very first importance. Since the above suggestions were offered, more especially regarding the possible physiological changes in the growth of the plant, considerable progress has been made. **Veterinary-Captain Pease** (*Agricultural Ledger, 1896, No. 24*) recorded the death of a large number of cattle at the Sirsa fair, due to their having eaten *juár* stems. A parcel of the stems was subsequently examined by **Mr. T. Stephenson**, Analytical Chemist, Bombay, and found to contain 75 grains of nitrate of potash per ounce weight of the plant. Moreover, that salt was found to be unevenly distributed throughout the plant, being most abundant in the stem at the nodes or junctions of the leaves. **Captain Pease** observes: "There can be no reasonable doubt that in the cases of poisoning from the plant the cause is the presence of large quantities of nitrate of potash in the stems." On the other hand, **Dunstan** and **Henry** [*Philosoph. Trans. of the Royal Society, 1902* (*199 A*), *399*] in a very learned paper on the *Cyanogenesis in Plants* have shown that the poisonous property of immature

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Sorghum is due to the presence of prussic acid originating in a new glucoside named *dhurrin*. They have furnished a full account of the formation of the poison and of the enzyme which has the power of hydrolysing *dhurrin*. But it should be observed that these authors expressly say that the prussic acid has only hitherto been detected in "the young plant." And they add, "It appears that animals, indigenous to the countries in which these plants are native, refuse to eat them in the earlier and poisonous stages of growth."

The poisoning referred to by Pease occurred in consequence of cattle having been given plants stunted through the failure of the rains and the abnormally high temperature that prevailed at the time. The fodder therefore certainly did not consist of young plants or thinnings from a field of seedlings.* Capt. Pease further remarks that it is a very general belief that **Sorghum** rendered poisonous through being stunted might subsequently become innocuous by a liberal supply of rain, or even (he suggests) through washing thoroughly the prepared fodder before it is given to the cattle. Dunstan and Henry, on the other hand, observe that according to Floyer the *Dhurra* "is planted chiefly in order to shade the **Arachis** (ground nut), to which it also affords protection in forming a poisonous hedge. The 'thinnings' of the young millet are often strewn around a cultivated crop, and the neighbours are warned to keep their cattle off. The poison is most intense when young plants, one foot high or less, are kept without water for a long time, and such unwatered young plant is highly toxic to cows."

References.

By way of concluding this brief review of information the following references to more recent opinions may be useful. In the *Board of Trade Journal* (*Supp. 1903, XIV*) it is observed "the amount of prussic acid obtainable from *Dhurra* is in the case of plants 18 inches to 24 inches high ·25 per cent., beyond this stage the amount rapidly diminishes, and in the mature plant the cyanogenetic glucoside has entirely disappeared." As having a bearing on the belief that the roots also are poisonous reference may here be made to an article in the *Journal of the Society of Chemical Industry* (*XXII, 1903, p. 226*), in which, while discussing the presence of prussic acid, it is affirmed the poison occurs most abundantly in the stalks, less in the leaves, and not at all in the roots. Brunnich (*Queensland Agric. Journ., XIII, 1903, p. 94, also Journ. Chem. Soc., No. 448, pp. 788-796*) in his paper on Hydrocyanic Acid in Fodder Plants says that the quantity is increased by high nitrogenous manuring. He further observes that as soon as the seeds are ripe the plant becomes innocuous. The poisonous nature of Sorghum as fodder has aroused much attention in Australia, and Dr. W. Maxwell in the *Queensland Agricultural Journal* has contributed useful additional particulars (*see Vol. XIII. (1903), pp. 59,*

* Lieut. Col. D. St. Grant in 1903 reported a case of cattle-poisoning near Ranchi, Bengal, as the result of the eating of young shoots springing from old roots.—ED.

WHEN IS SORGHUM POISONOUS?

93, 293, 473). The subject has also been taken up by various investigators in the United States of America (*see Agri. Dept. Exp. Stat. Record XIV, 1903, pp. 298, 701, 921*). Slade has, for example, pointed out that a very great variability exists in the amount of prussic acid present in the different varieties of the plant. An extensive series of quotations might be given in support of the Indian belief that **Sorghum** only becomes poisonous when stunted in its growth through insufficient rainfall and abnormally high temperatures. In no instance has an Indian writer recorded so pronounced an opinion regarding the poisonous property as that given above in connection with Egypt. Nowhere in India is the poisonous property of withering seedlings taken advantage of to protect other crops from the depredations of straying cattle. Dr. Voelcker (*Report Improv. Ind. Agric., 1893, p. 92*) and one or two other writers say, however, that **Sorghum** is grown around the borders of fields "to keep cattle from trespassing on to the crops." "Where hedges are not grown, it is not infrequently the case that a few rows of a special crop, such as linseed, hemp, or **Sorghum** are put round a field in order to protect the main crop." [*"Sorghum as a Forage Crop" by* Williams *in U. S. Farmers' Bulletin, No. 50 (1899); "Forage Crops," by* Lyon *and* Hitchock, *U. S. Bur. of Plant Industry, Bul. 59, 1904.*]

Sugar Sorghum or Imphee.

SUGAR SORGHUM.

It may have been noted, from some of the observations already made, that forms of Sorghum with sugar-yielding stems must have been well known to the people of India many centuries ago, and thus long anterior to any recorded introduction of these plants from China or Africa. It may also be pointed out that since the word *Sorgo* (*Sorgho*) originated in the South of Italy, it would be a safe deduction that it had been first applied to (and had best be restricted to) the grain and fodder forms that are believed to have been produced in Europe, in North Africa (Egypt), in the United States of America, in the more northerly tracts of China, and in the more elevated regions of India. In other words, it would be useful if the word *Sorgo* were exclusively given to the warm temperate, in contradistinction to the tropical forms. In the same way the name *Imphee* (which means sweet-cane) was introduced into Europe and America about the year 1854 by Mr. Leonard Wray, as being the Kaffir name of the special sugar-yielding plant which he found in South-East Africa and which he urged so warmly as deserving of the attention of the sugar-growers of the world. Some few years previously identically the same plant had been sent from China to France by Montigny and came rapidly into favour as a rich fodder grass. It seems, therefore, desirable on both historical and botanical grounds to assign the name *Imphee* to the sugar-yielding and *Sorgo* to the temperate grain-yielding forms of the species. By most writers these names are, however, used synonymously, a usage justified by the

Discovery of Imphee.

SUGAR SORGHUM.

fact that a sugar-yielding form may, when carried from one country to another, become a grain or fodder form. The separation recommended, though it would be useful, could not therefore be arbitrarily enforced, the more so since it by no means follows that all the sugar-yielding stock now known came from Africa or China, any more than all the *Sorgos* originated in Italy, India, China and Africa have each more or less parallel assortments of cultivated races of **Sorghum vulgare,** both temperate and tropical, and interchanges have no doubt taken place for centuries past between all three countries. The majority of the forms of *Sorgo* proper and of Imphee proper belong, however, to the botanical assemblage accepted as derived from the same variety (or closely allied varieties) of the species. To a large extent also they correspond with the *rabi juár* of the plains of India. They are the plants most generally prized as sources of fodder because of being sweet and of possessing the property of rattooning and of sprouting from stools after being cropped. Lastly, as already pointed out, they are the cultivated conditions which approximate most nearly to the wild plant **S. halepense**—a plant indigenous to large tracts both of India and of Northern Africa. The separation, moreover, of the plants that may be accepted as corresponding with the *Sorgo* and the Imphee, leaves a vast assemblage of tropical forms such as the *juár* proper of India. While these are doubtless represented both in Africa and China, a stronger case exists for at least the majority being accepted as indigenous to India, than can be made out for either of the other countries named. The separation of the forms of **Sorghum** met with in India into two great groups that may be spoken of as corresponding with **S. halepense** on the one hand and with **S. vulgare** on the other, was urged in the *Dictionary of Economic Products*. That isolation seems of infinite practical value and should be kept clearly in view in every attempt to improve the Indian stock.

Affinity of sugar yielding races.

The reports and journals of our Agricultural Departments, Experimental Farms, and Agri-Horticultural Societies literally teem with accounts of the efforts that were made from one end of India to the other to acclimatise the Chinese and African sugar-yielding **Sorghums.** And in many cases plants which in all probability should have been treated as *rabi* were grown as *kharif* crop; failure being a natural consequence. After a careful perusal of the extensive literature concerning acclimatisation experiments, two convictions arise in one's mind: *first,* that no practical result of any great value has been attained: and *second,* that meantime the study of the indigenous forms has been utterly neglected. It is impossible even now to say for certain what forms of *juar* and *Sorgo* exist in the provinces of India or to furnish a concise statement of the systems of cultivation pursued. We read, for example, that in Bikanir and Ajmer a form of sugar-yielding **Sorghum** known as the *Alipura* has been known and cultivated from time immemorial and used in the

Attempts at cultivation in India.

Cultivation in India.

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SUGAR SORGHUM.

preparation of the sugar-candy for which these towns are famed. This statement aroused some attention and was freely discussed for a few years in the pages of the *Indian Agriculturist*, but seems to have been denied and forgotten from about 1890. In that year also an official enquiry in the Panjab resulted in the report that while in Ferozepore, Sialkot, and elsewhere sweet **sorghums** were known, the saccharine property was lost after a few years' cultivation in other districts to which these plants had been experimentally conveyed. Interest was, however, once more aroused for a correspondent in the *Civil and Military Gazette* (*September 1899*) wrote that an officer of the Patiala State had started to prepare sugar from the **sorghum** grown on the Himalaya.

"Collier" and "Amber" grown in India.

Of the exotic forms the **Amber** and the **Collier** seem to have attracted most attention. But the Poona Farm Report (*1895, p. 9*) arrived at the opinion that there was little to choose between them either in percentage of sugar or value as fodder crops. The weight of molasses per acre was found to be **Collier** 1,174 lbs. and **Amber** 1,072 lbs. The final conclusion arrived at by most Indian investigators may be said to be that the yield in India is too poor to pay. Sugar-cane in tropical countries and beet in temperate seem likely to bar the way to any immediate development of **Sorghum** sugar. The *Kew Bulletin* (*April 1897, p. 173*) points out that **Sorghum** can be grown in countries considerably to the north of the sugar-cane area. This is an important fact of which full advantage has been taken in America.

Difficulties in Sugar-making.

The United States Department of Agriculture in their Year-Book for 1900 (*p. 242*) would seem to set forth the true position of this subject. "An increase in the amount of sugar extracted from the canes was easily obtained, but the greatest difficulty in the way of successful sugar-making still remained, namely, the chemical composition of the extracted juices. It was found that the juices extracted from **Sorghum** canes contain large quantities of starch, gummy matters, and uncrystallizable sugars. These existed in such large proportions as to render the separation of the sucrose in large quantities practically impossible." After discussing the chemical experiments made in the effort to overcome these difficulties it is observed, "Meanwhile other investigations were carried on with great success: among them the process of developing a variety or varieties of **Sorghum** in which the objectionable qualities would be reduced to a minimum and the percentage of sugar raised to a maximum. This desirable end was accomplished by a series of culture experiments in co-operation with Mr. A. A. Denton, extending over eight years in which by a process of selection..............several varieties were developed, which were far superior to any which before had been known." "In spite of all the progress that had been made, however, it was found that the increasing competition of the sugar beet had decreased the price of sugar in the world's markets, until it would not be profitable to manufacture sugar from **Sorghum**, even under the more favourable circumstances which have been obtained." [*Conf. Note on Sorgho, Rev. Dept. Govt. of Ind., 1877, by F. G. Wigley; U. S. Dept. Agri. Production of Sugar from Sorghum, Bul. No. 26, 1890; Experiments with Sorghum, Bull. No. 29, 1890; No. 34, 1891; and No. 37, 1892, all*

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by H. W. Wiley, Chemist to the Dept.; Year-Book, 1897, p. 80; 1899, pp. 242-3; Exper. Stat. Record, X., 1899, p. 345; XI., 1900, pp. 141, 319, 883; XII., 1901, pp. 236, 547, 942; XIII., 1902, pp. 42-3, 242; XIV., 1903, p. 757; U. S. Farmers' Bull. Nos. 90, 92 (1899); Agric. Gazette, 1891, p. 134; 1894, p. 578; Journ. Agric., S. Australia, V. (1902) p. 876; Rev. des Cult. Colon. II. (1902), p. 51; Journ. Soc. Chem. Industry. XXI., (1902), p. 628. SUGAR SORGHUM.

Spirit.—Many writers allude to the fact that the Africans manufacture a sort of beer from the grain of **Sorghum**. One of the natural results of the inquiry into the sugar **sorghums** was the question of their being utilized in distillation. In 1884, Messrs. Minchin Brothers of Aska, Ganjam, reported that the juice of **Sorghum** was most valuable to distillers. The spirit prepared is said to have tasted much like rum, but after being opened was liable to throw down a gelatinous looking substance. Nothing further has been heard on the subject in India, and in the United States of America it has generally been said that change in the fiscal law of the country would be necessary before it could be utilized. SPIRIT MAKING. Suggested in India—Dropped.

Industrial Uses.—The value of the thicker and drier stems as fuel is fully understood in India though they are only incidentally utilized. In fact the plant is so very valuable as a fodder for the cattle that remarkably little is, as a rule, available for fuel. The culms are sometimes made into pens, more especially those of the wild species. In Southern Europe and America a special form of the plant known to botanists as **var. technicum** is specially grown in order that (after the removal of the grain) the rigid, strong, much-branched fruiting shoots may be employed as natural brooms and special qualities for small hand-brushes or whisks. Mr. W. J. Hannan (*Textile Fibres of Commerce, 1902, p. 158*) gives incorrectly a photograph of the compact headed forms of **Sorghum** as being that of the Broom-Corn. Reference has already been made in the paragraphs devoted to History to the leading German authors, who have written on this subject. Mr. C. P. Hartley has given a detailed account of this special product in the *Farmers' Bulletin, No. 174*, published by the United States Department of Agriculture in 1903. The form of the plant that should be selected for that purpose, Mr. Hartley tells us, "differs from all the others of the same species in having panicles or seed heads with much longer, straighter, and stronger branches or straws." "It is for the seed heads, or 'brush' as they are called, that the plant is cultivated." It would seem there are two chief forms, known as "standard" and "dwarf." The former has longer and stronger straws and is accordingly used for large brooms, while the latter is shorter, but has fine, straight, elastic, and uniformly green straws. The dwarf fetches the highest price, and is used for hearth brooms, whisks, and cloth brushes. [*Conf. Dodge, Useful Fibre Plants of the World, p. 59.*] BROOM CORN.

Trade in Juar.—It is exceedingly difficult to furnish any very definite statement regarding the traffic in the products derived from **Sorghum vulgare** in India, for the simple reason that as a rule the official statistics treat of the two millets—*judr* and *bajra*—conjointly. It would, however, be fairly safe to assume that ⅔rds of the TRADE.

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TRADE.

quantities recorded are in reality *judr*, the balance being *bajra*. The estimate of total production given above for *judr* alone comes to 100 million cwt. of grain. The exports of *judr* and *bajra* together during the past five years have averaged 738,000 cwt.; $\frac{2}{3}$rds being *judr* we thus learn that the total exports do not seriously exceed one-half per cent. of the production. *Judr* is, therefore grown primarily to meet the food necessities of the people and not (as in the case of rice in Burma) as a rent-paying article of export. The area of its production can alone be curtailed by the consumption of some other article of food either produced or imported. The necessary nature of the crop may be gathered from the interchanges which constantly take place between the provinces of India during seasons of scarcity or famine. And this is an interesting new feature of Indian economy in direct consonance with the rail and road facilities of interchange.

The quantities of *judr* and *bajra* conjointly shown as carried by rail and river average about 6 to 7 million maunds in normal years. The maund varies in the different provinces, but in Bengal it is 82$\frac{2}{7}$lbs. The famine of Western India at the end of the past century caused a demand for these millets responded to by the other provinces. In the year 1899-1900 the rail and river traffic came to close on 16 million maunds; in 1900-01 it stood at 12$\frac{1}{2}$ million; in 1901-02 at 11$\frac{3}{4}$ million maunds, but in 1902-03 it fell to its normal condition of 6$\frac{3}{4}$ million maunds. Now, during these years of scarcity and famine, Bombay Presidency imported in 1899-1900, 6 million; in 1900-01, 6$\frac{3}{4}$ million; in 1901-02, 4$\frac{1}{2}$ million; and in 1902-03, 2 million maunds, while the town of Bombay itself took in addition 3$\frac{1}{2}$ 1, $\frac{3}{4}$, and 1$\frac{1}{4}$ million maunds. These supplementary supplies were drawn from Madras, the United Provinces, Sind, &c.

Turning now to the records of the coastwise traffic we obtain a similar indication of the inter-dependence of the provinces of India for this all-important food-stuff, especially during abnormal years or local climatic disturbances. The returns of imports show that Bombay draws on Sind, Madras, and Burma and exports to Kathiawar and Kach.

PRICES.

Prices.—The official returns (*Prices and Wages in India*) afford some useful particulars. The mean average price of *judr* for all India during the years 1871-75 is taken as 100, the standard of comparison of relative prices in the districts and provinces of India, also of accidental disturbances. A careful study of these returns reveals the fact that with every extension of the facilities of internal trade a balance or adjustment in food takes place. Where a grain like *judr* may have been abnormally cheap the price rises with the facilities of export, while other articles, formerly too highly priced, fall

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in value with the additional supplies obtained. During the quinquennial period 1896-1900 (which includes a term of scarcity and famine) the mean average for the whole of India was 153·6 and in 1903, when the effort of the famine had been effaced, it stood at 109·23, but if three provinces be removed from consideration, namely, Berar, the Panjab, and Sind, the mean average for the whole of the rest of India becomes 1·006. In the three provinces named (except some districts of the Panjab) *judr* never seems to have been procurable at the price expressed by the standard of 100. As exhibiting the actual prices of this millet, it may be here stated that, expressed in seers (=2 lbs.) and decimals of seers, obtainable for one rupee (or 1*s*. 4*d*.), the returns of Burma in 1903 show 24·76; Bengal 19·75; Agra 22·5; Oudh 25·21; Rajputana 23·51; Central India 28·14; Panjab 21·88; Sind and Baluchistan 18·67; Bombay 22·84; Central Provinces 25·53; Berar 22·44; Nizam's Territories 20·81; Madras 26·15; and Mysore 26·24. Thus the provinces where this grain is normally most expensive are Sind, Bengal, Nizam's Territories, and the Panjab.

The most significant feature of the internal trade returns is perhaps the circumstance that Bengal practically takes no part in the traffic. Millets are in fact very little consumed in Bengal. Another feature of the trade may be said to be that the great producing areas export to tracts of country inhabited by simple agricultural communities or to regions where modern civilization with its concomitant luxury has not penetrated to any material extent.

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(Industrial Series, No. 5.)

THE AGRICULTURAL LEDGER.

1905—No. 7.

CROTALARIA JUNCEA, *Linn.*

(SUNN HEMP FIBRE.)

[*Dictionary of Economic Products, Vol. II.*, C. 2105-2147.]

The Fishing Nets of the Kolis of Bandra, Bombay Presidency. By V. P. RIBEIRO, *Extra Assistant Conservator of Forests, Hyderabad (Sind).*

KOLIS.

[The Kolis are a race of the West Coast of India divided into a large number of tribes. Their settlements stretch from the deserts north of Gujarat to Ratnagiri, inland by Pandharpur in the south of Poona as far east as the Mahadev or Balaghat hills in the Nizam's Dominions and through the Central Provinces and Berar, north to Khandesh.* They are found in every village in Gujarat, the Konkan and the Deccan. They are skilful husbandmen and raise the finest kinds of rice. One tribe settled just north of Bombay is that of the Meta or Dungari Kolis and consists of fishermen who use among their nets those here described.—Ed.]

CROTALARIA JUNCEA. Vernacular names.

"The nets used by Kolis are made from the fibre of **Crotalaria juncea** (vernacular name "*Tag*"), and are of 3 or 4 distinct shapes adapted to different depths of water, and to different fish.

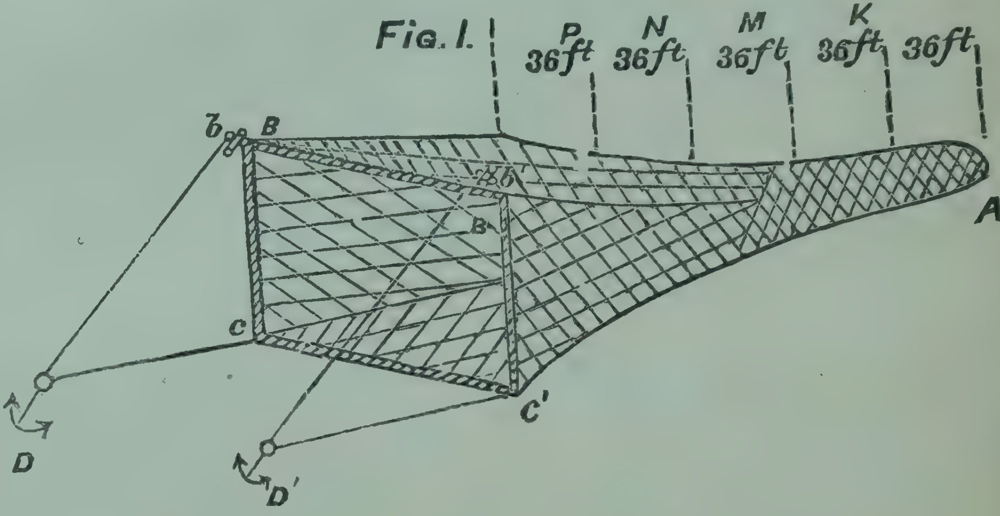
A net, known among the Kolis as "*Dowl*" or "*dole*" is considered to be the best, and is used invariably for deep sea fishing, and for all kinds of fish. When spread into the sea, it assumes a pyramidal or conical shape, as shown in the accompanying rough sketch.

The length of this net, from apex A to base B, is 162 feet. Each side of the base or mouth B B′, B C, B′ C′ and C C′ measures 72 feet, *i.e.*, the whole measurement round the base is 288 feet.

* Dr. T. Wilson held that the name was Kuli or clansmen, that they were the aboriginals of the plains while the Bhils were the aboriginals of the hills.—*Bombay Gazetteer, Thana, Vol. XIII., Part I.*

CROTALARIA juncea

The Fishing Nets of the Kolis of Bandra,



DIMENSIONS OF NET.

The apex A is tied with a string, when the net is spread, and can be opened when it is necessary, to remove the fish. Its base or mouth B B′, C C′ is open, and a strong rope passes round it. In the accompanying sketch b and b′ are two buoys or empty casks about 72 feet apart, floating in the sea, and kept in position by two anchors D and D′ to which they are fastened by two strong ropes or hawsers. The two corners B and B′ of the net are attached to the two buoys b and b′. The other two corners C and C′ of the net are fixed to the two anchors by a pair of strong ropes C D and C′ D′.

When the net is full, the thin ropes b c and b′ c′ are pulled, so as to raise the corners C and C′ to B and B′. This has the effect of closing the mouth of the net. The net is then detached from the buoys and anchors, and hauled into a boat alongside of it, and the fish removed by unfastening of apex of the net. The buoys and anchors with ropes remain permanently in the sea.

In fair weather the anchors and casks are sometimes dispensed with, and the net is fixed to two masts (preferably of **Adina cordifolia,** it being very durable under water) sunk upright in the sea from 70 to 80 feet apart. The working of the net under these conditions will be clear.

Placing of Nets.

In this case the corners C and C′ have lead weights attached and they (the corners C and C′) are raised (when necessary to close the mouth of the net) by ropes and pulleys at the top of the masts (as shown in figure 2 in the accompanying diagram).

Value of Net.

The value of this net (of the size given above) is R250 and it costs about R8 a month for tanning. The meshes of the "*Dowl*"

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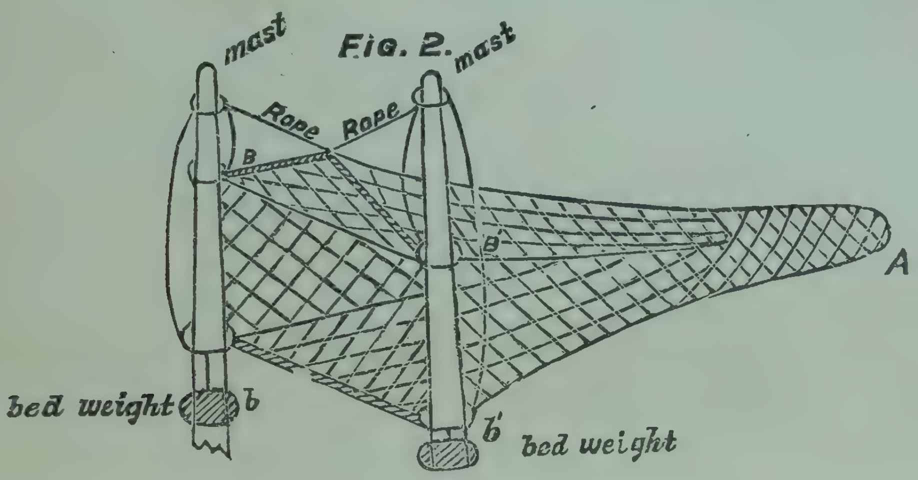
Fig. 2.



net vary from $6\frac{1}{2}$ inches to $\frac{1}{4}$ inch. The size of the mesh near the mouth is $6\frac{1}{2}$ inches and it gradually decreases to $\frac{1}{4}$ inch towards the apex. For regulating the size of mesh, the net is divided into 5 parts which are named as follows :—

Vernacular names of meshes.

Khola = a length of 18 feet from A apex with a $\frac{1}{4}$ inch mesh.
Mazola = 36 feet from K to M with a $\frac{1}{2}$ inch mesh.
Chiret = 36 feet from N to P with a mesh from $1\frac{1}{2}$ to 3 inches.
Mowr = 36 feet P B′ with a mesh of 3 to $6\frac{1}{2}$ inches.

Nets similar in shape and make as the above but of smaller dimensions (30 feet long and 27 feet in circumference) are called "*boksha*," and can be had for R10.

Jahal Net.

Another kind of net is the "*Jahal*"; the mesh of this net is $2\frac{1}{4}$ inches. It is 240 feet long and 24 feet broad and has very small wooden floats attached longitudinally, 10 feet apart along one edge of the net, and a strong rope passes along the other edge. It is used in moderately deep water, for pomfrets and other similar fish. Such a net costs from 8 to 9 rupees.

Airkhund Net.

"*Airkhund*" is a net of smaller dimensions (36′ × 18′) and may be characterised as a sweep net. It is used in shallow water on the coast or in creeks. It is dragged over the fishing ground by men in boats or wading in water. Its mesh is $\frac{1}{2}$ inch.

Pagh. Assu.

Another class of nets consists of the "*Pagh*" and "*Assu*." The first is circular in shape, the diameter being about 18 feet.

To its circumference are attached lead weights, at short intervals. It may be called the "Casting out" net, and is used in shallow water, to catch small fish and prawns. The mesh of the *Pagh* is $\frac{1}{8}$ to $\frac{1}{4}$ inch.

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CROTALARIA juncea.

The Fishing-Nets of the Kolis of Bandra, Bombay Presidency.

The "*Assu*" is a hand net similar to the "*dowl*" net but with a wooden rim (6 feet in diameter) and is employed on the sandy coast for catching prawns only. It may be called a dredge net. The mesh of this varies from $\frac{1}{4}$ to $\frac{1}{8}$ inch.

Fishing hooks and lines.

Traps and spears are not used among Koli fishermen. The hooks used are of the ordinary description. The lines are made of the fibre of **Caryota urens** and that of **Crotalaria juncea.**"

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FOR THE YEARS

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